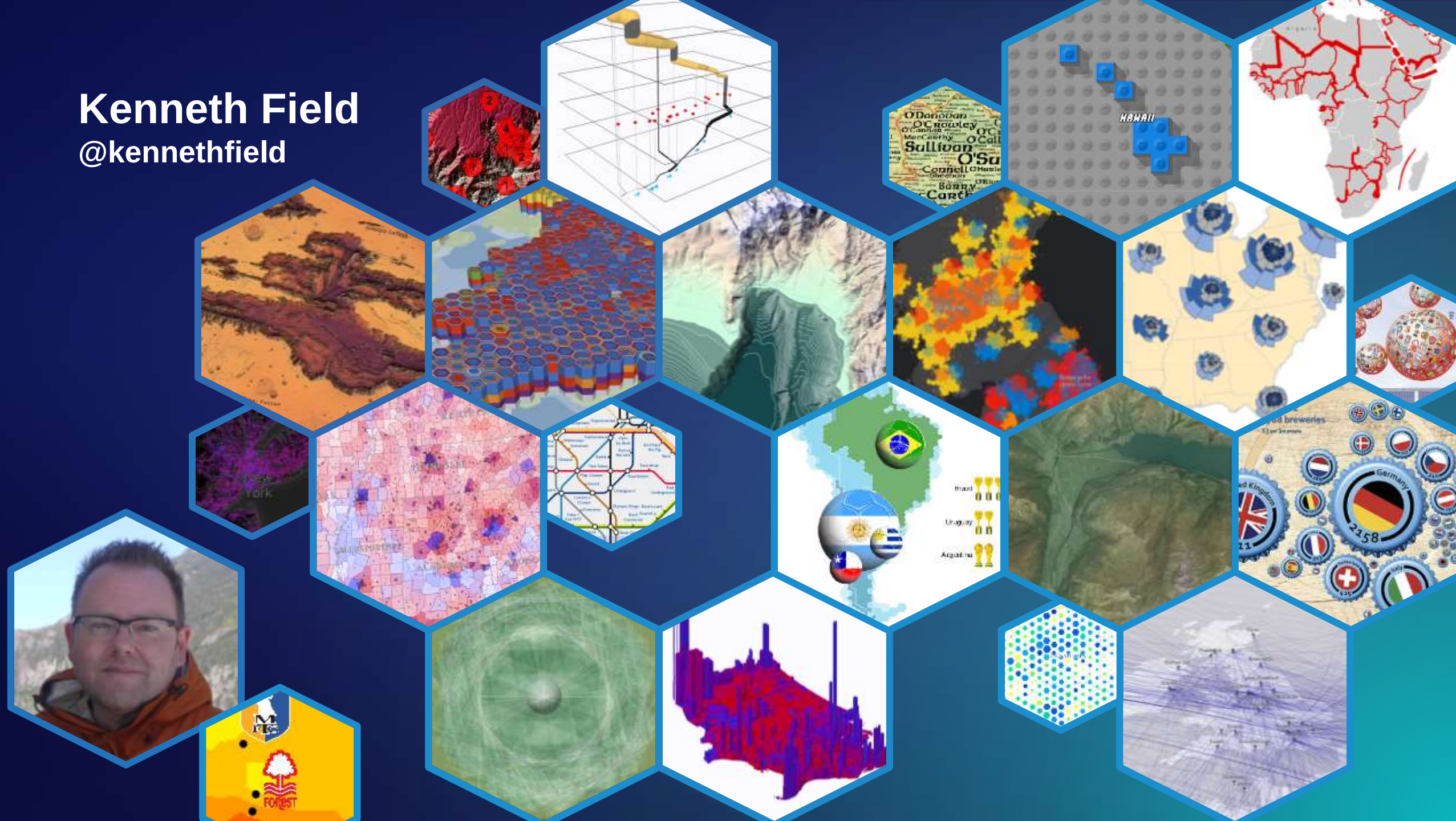
How to Make a Great Map

Kenneth Field and Wesley Jones

Kenneth Field

@kennethfield



Wes Jones

@wesleytjones

''Cartography is the discipline dealing with the art, science and technology of making and using maps.''

Menno-Jan Kraak

President of the International Cartographic Association

''Cartography, to me, is the art and science of simplifying the real world around us to tell a story using pictures.''

Ed Parsons

Geospatial Technologist of Google

''Traditionally, map making is graphic rendering of phenomena or relations on the earth. Now the term is expanded to general biobjective representations of spatially distributed relations. For example genetic maps.''

Waldo Tobler, deceased

Professor Emeritus at the University of California, Santa Barbara

''Cartography is the thinking that leads to smarter mapmaking.''

Kenneth Field

Professional cartonerd

Cartography as a language

C ompromise

A

R

T

O pportunity

G

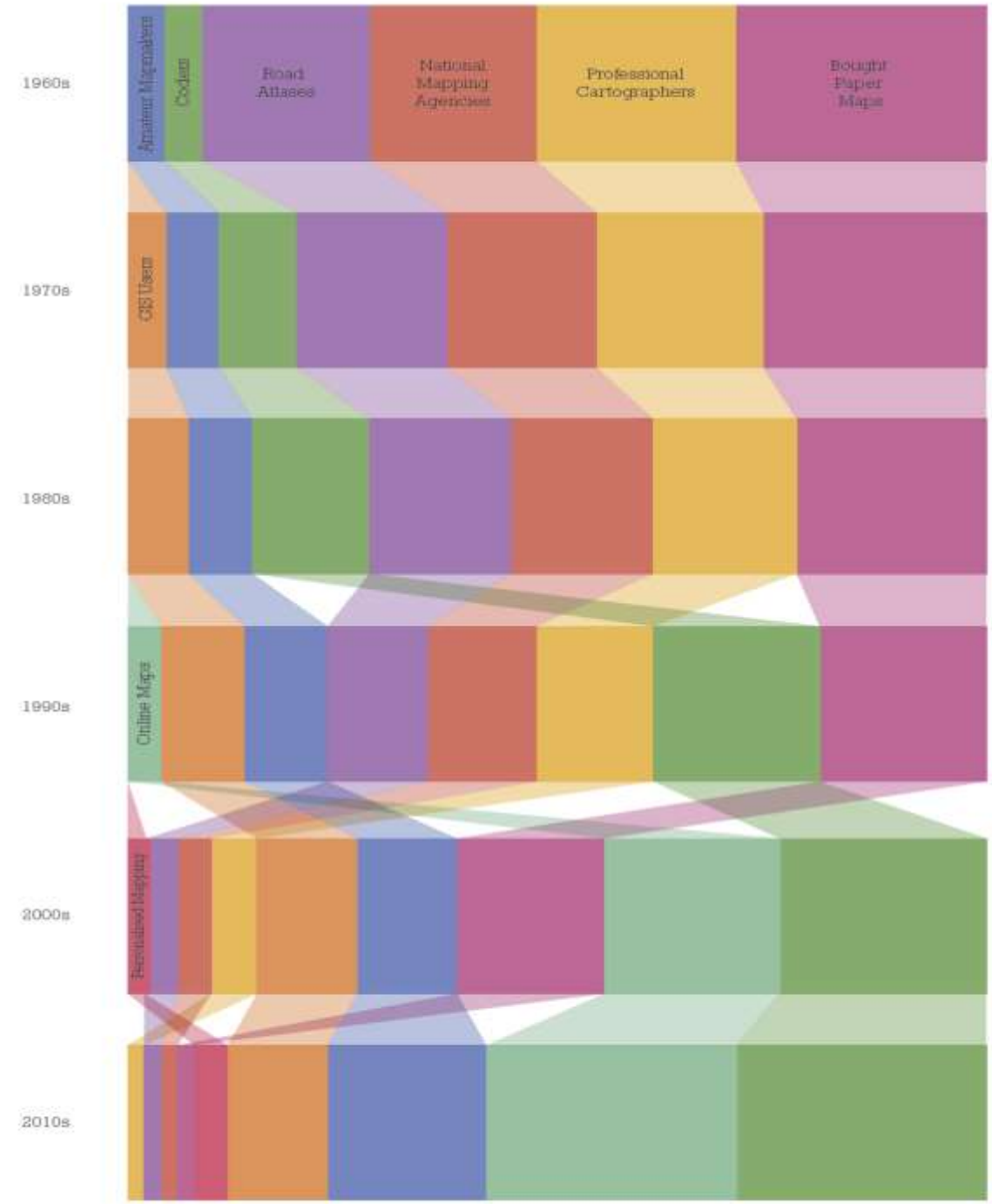
R

A

P

H

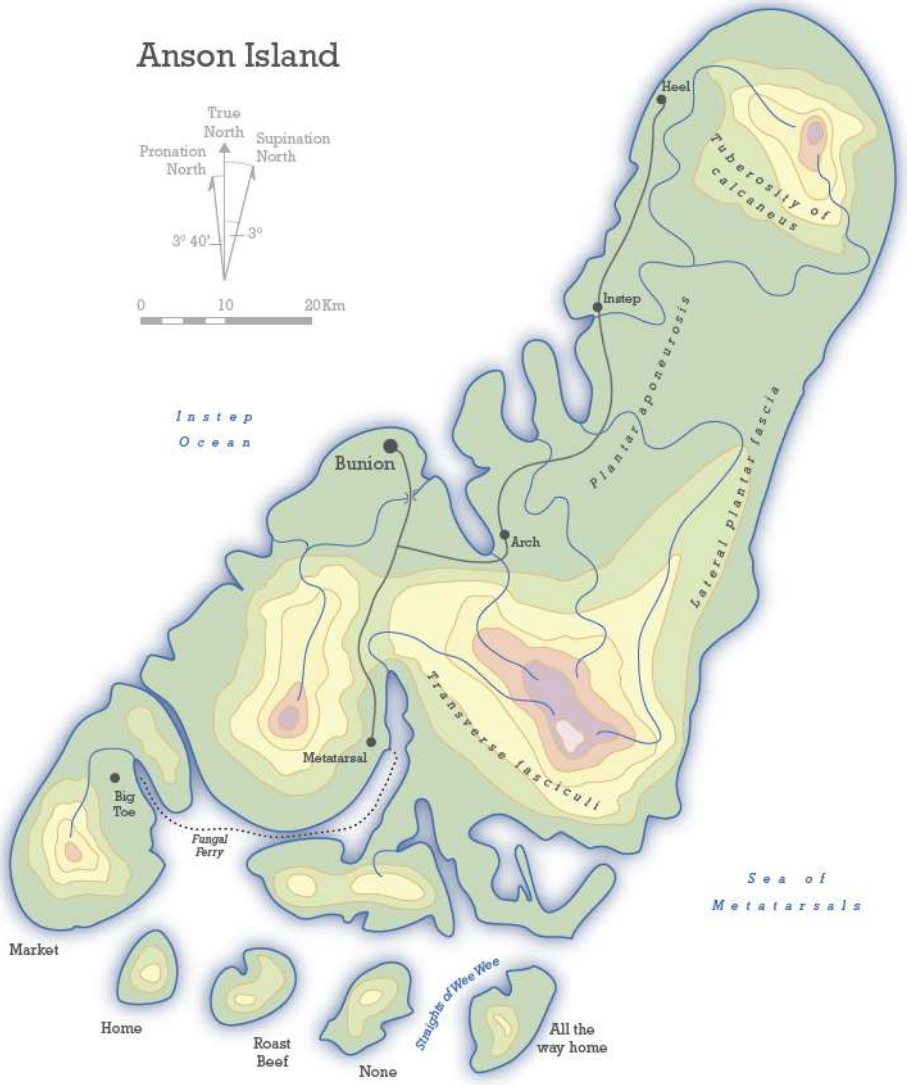
Y why?

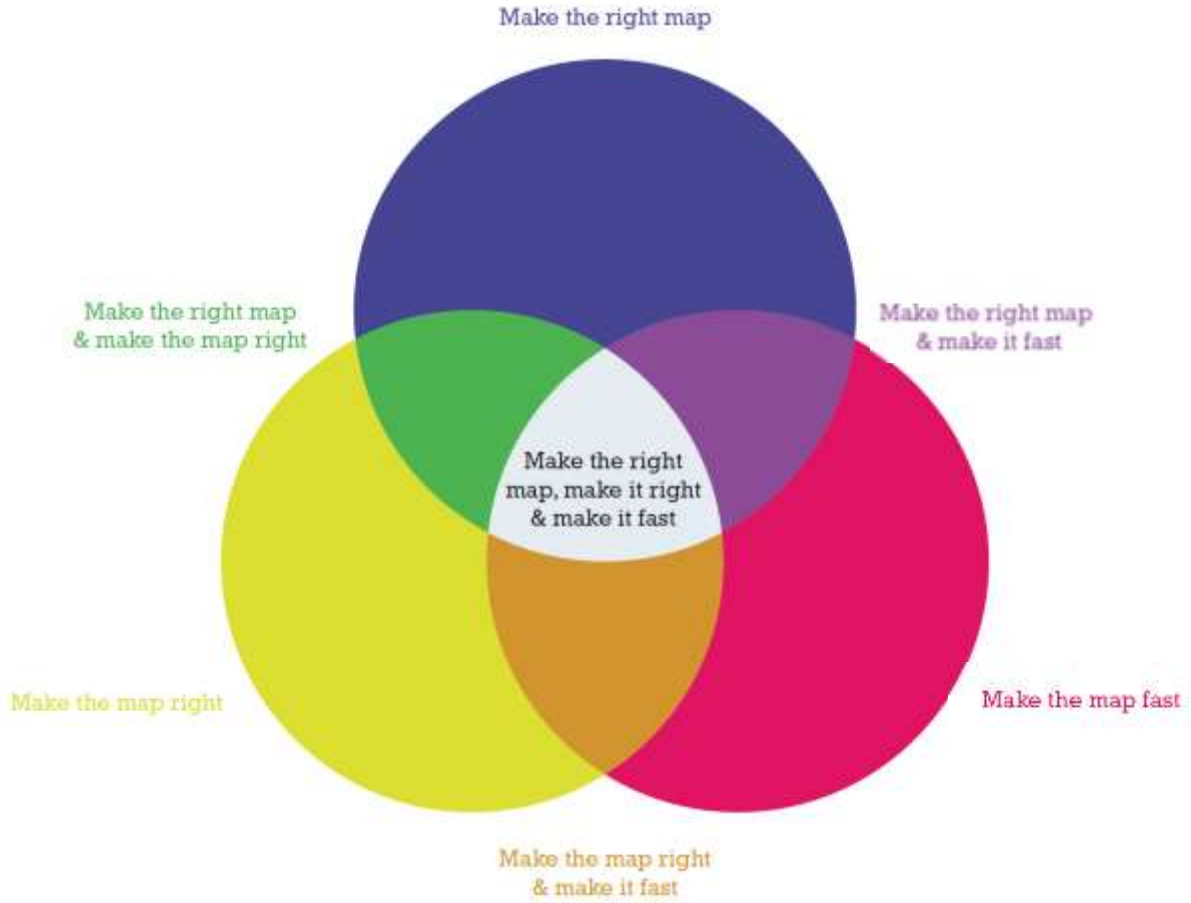


Serial, linear

Draw, stating your scale, a contoured map to show an island 65 km long from SW to NE which varies in width from 48 km in the SW to 16 km in the NE. The SW coast is much dissected by long, narrow fjord-like inlets, and is fringed by 5 small rocky islands of varying sizes. From this coast the land rises sharply to a plateau some 600 m above sea level and extending through about one-third of the island. The plateau descends to a low undulating plain about 25 km long and 20 km wide. From the plain a range of hills rises to the NE, flanked by a coastal plain about 8 km wide. From these hills, rivers flow to both plains and also from the plateau to the larger plain. The plateau is gritstone. The hills which run down to the coast in the NE, to form cliffs, are chalk. Much of the smaller coastal plain is marsh, but the larger plain, from which two estuaries open, is of well drained alluvial land. In addition to relief and topography, show drainage, possible sites of settlement and lines of communication. Name your island appropriately!

Parallel, non-linear

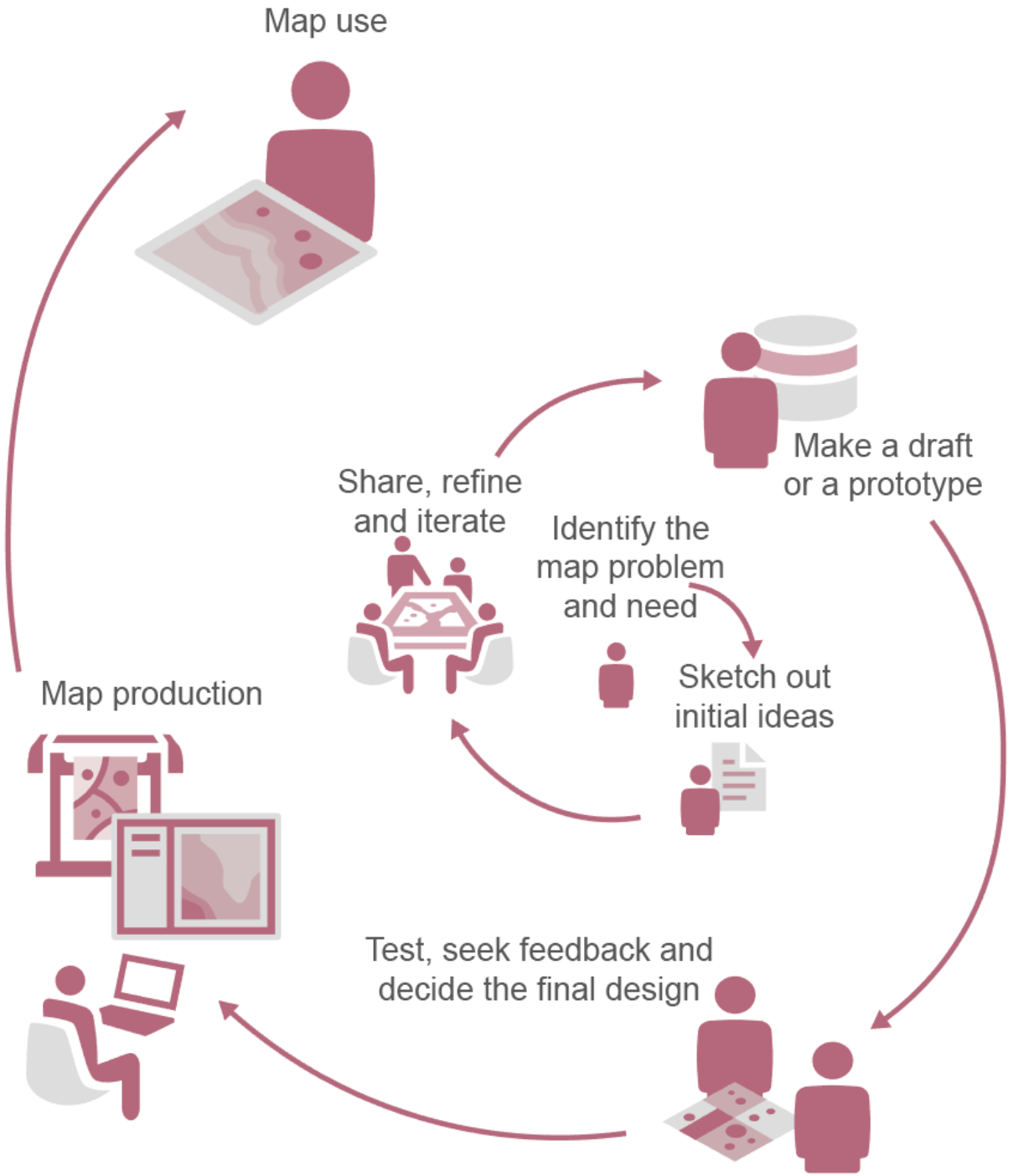




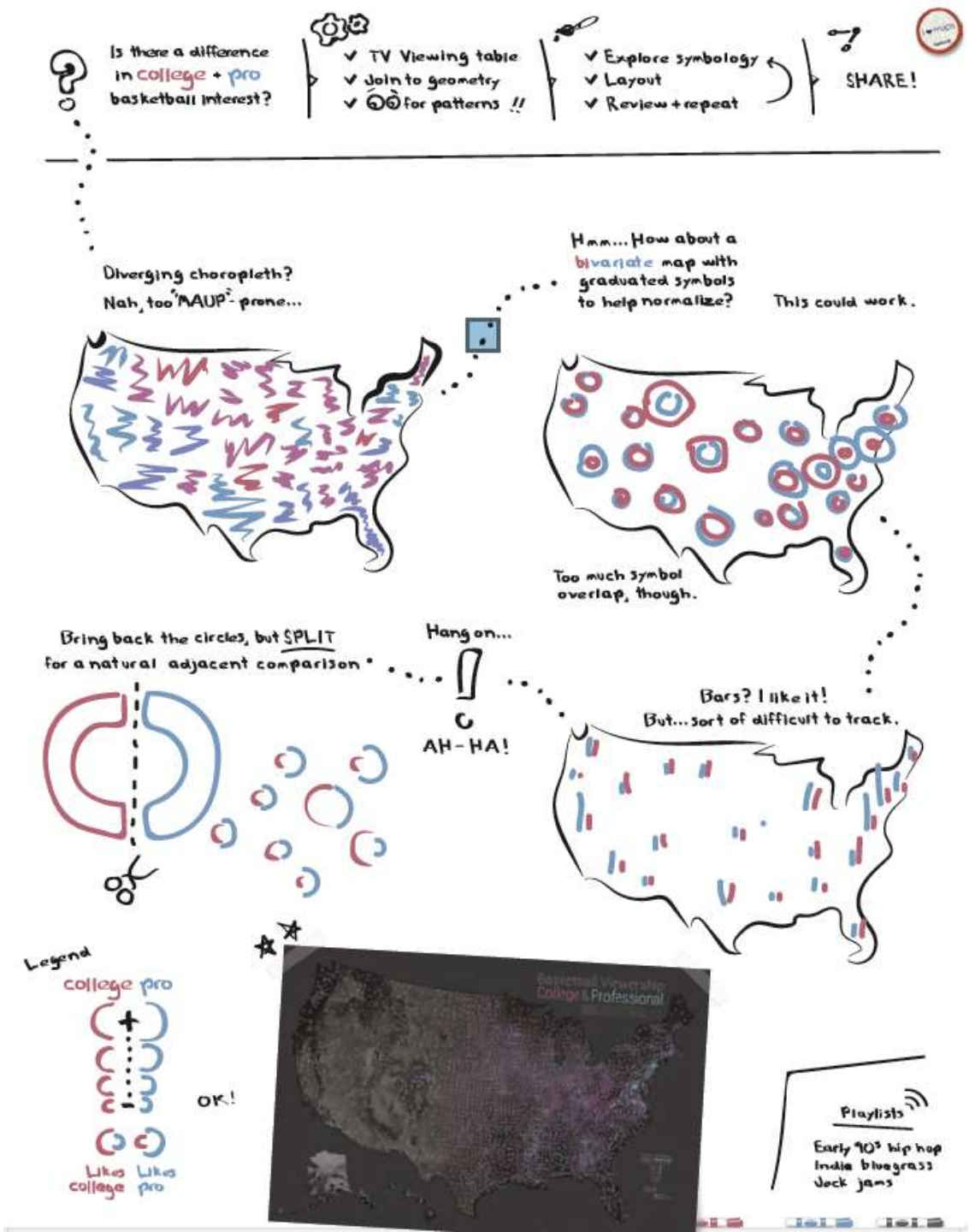
Some principles of map design

1. **Concept before compilation**
2. **Hierarchy with harmony**
3. **Simplicity from sacrifice**
4. **Clutter to clarity**
5. **Emotion expresses, engages, and elucidates**

The design process



Wireframing and Storyboarding



Constraints

Audience

Media resolution

Viewing distance

Output medium

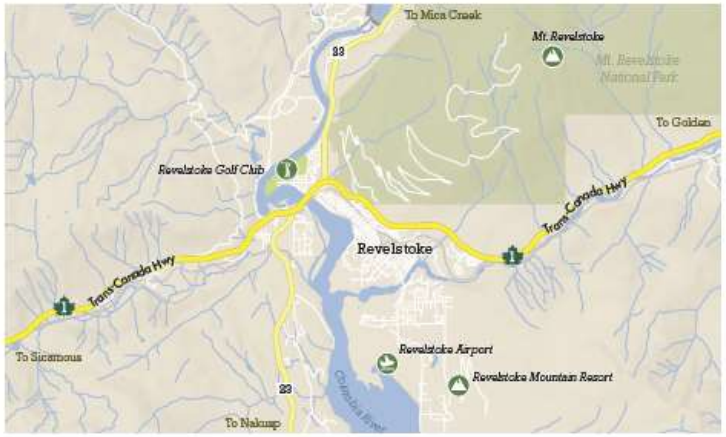
Anticipated level of understanding

Conditions of use

One map or multiple maps

What areal extent to show

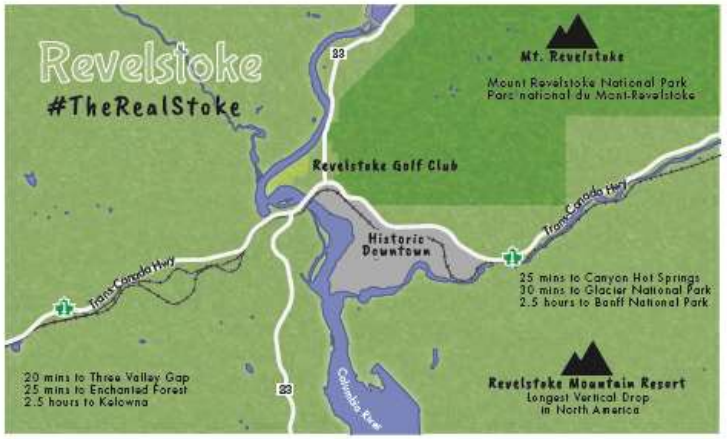
Insets/multiscale



ROAD MAP

Feature Emphasis

Road
Water
Elevation
Place name
Grid
Text
Icon
Colour
Surround

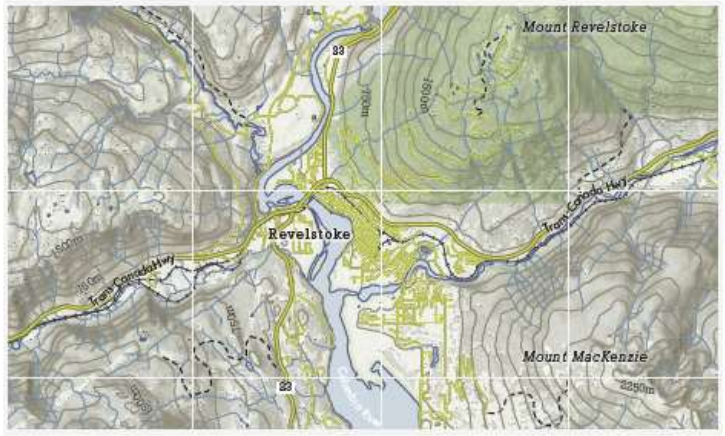


TOURIST MAP

Those 90s tourist placemat sort of maps

Feature Emphasis

Road
Water
Elevation
Place name
Grid
Text
Icon
Colour
Surround



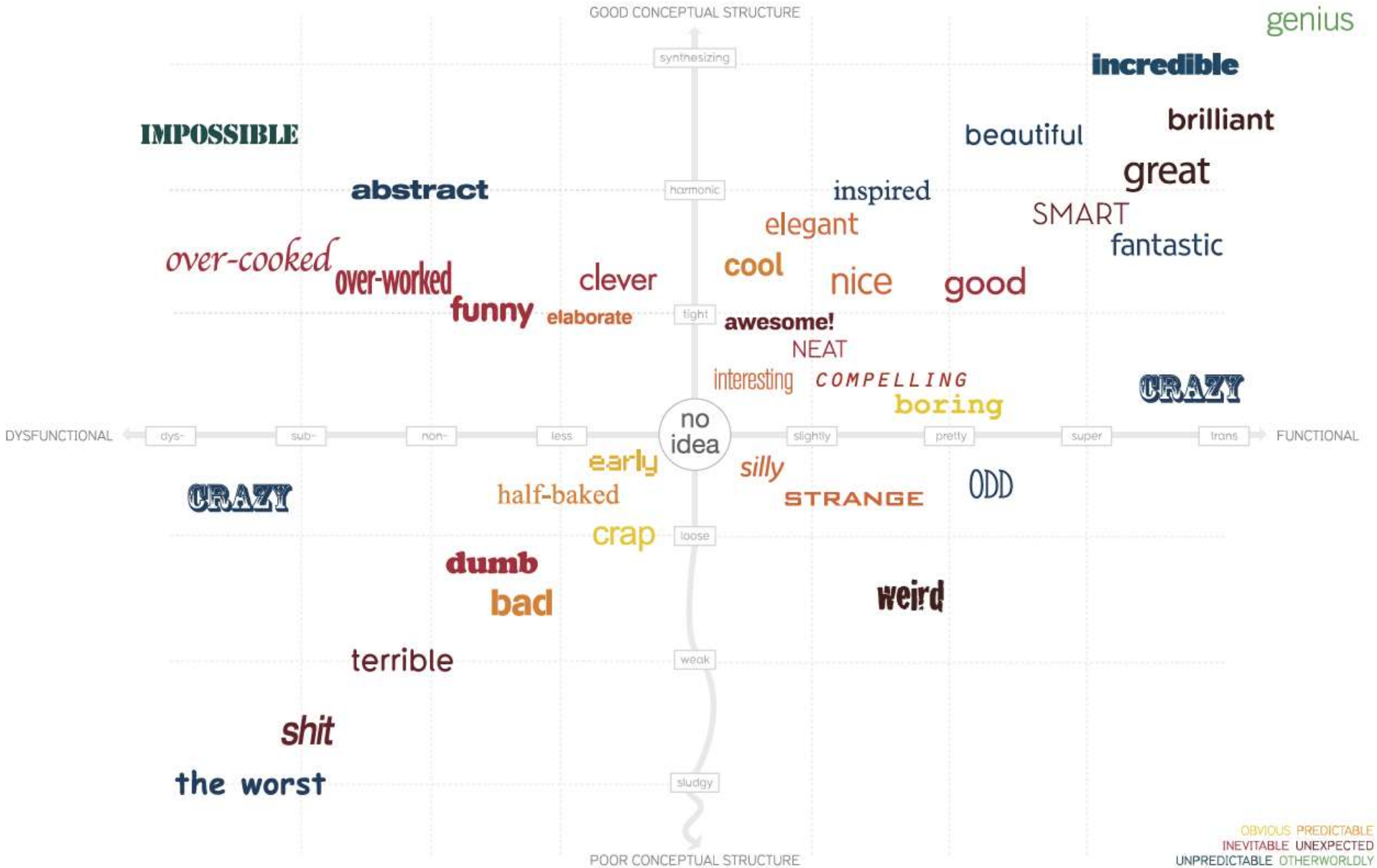
HIKING MAP

Feature Emphasis

Road
Water
Elevation
Place name
Grid
Text
Icon
Colour
Surround

A Taxonomy of Ideas

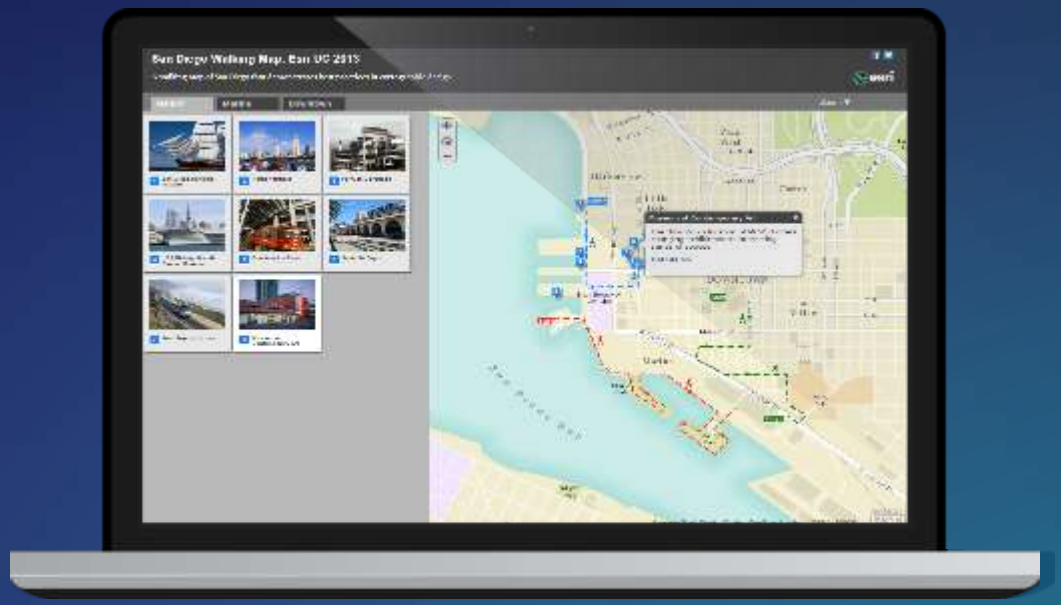
Structure + Functionality + Unpredictability?



By David McCandless informationisbeautiful.net

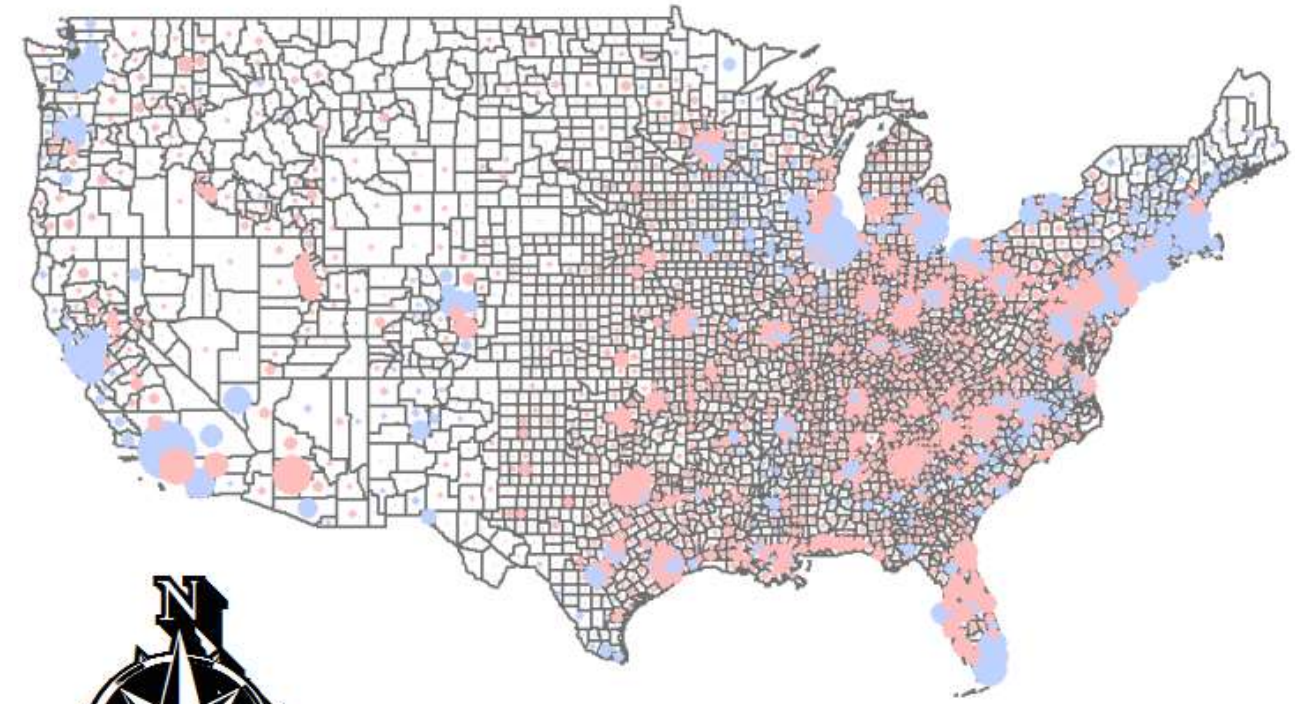
Wes, what's the map?

San Diego Walking Map
Little Italy
Harborview
Core-Columbia
DOWNTOWN
Broadway
Horton Plaza
Gaslamp
East Village
Cortez
Marina
Meters
Legend
Downtown walk
Marina walk
Museums walk



Design hierarchy

CLINTON vs TRUMP 2016



200100 0 200 400 600 800
Miles

Legend

Republican

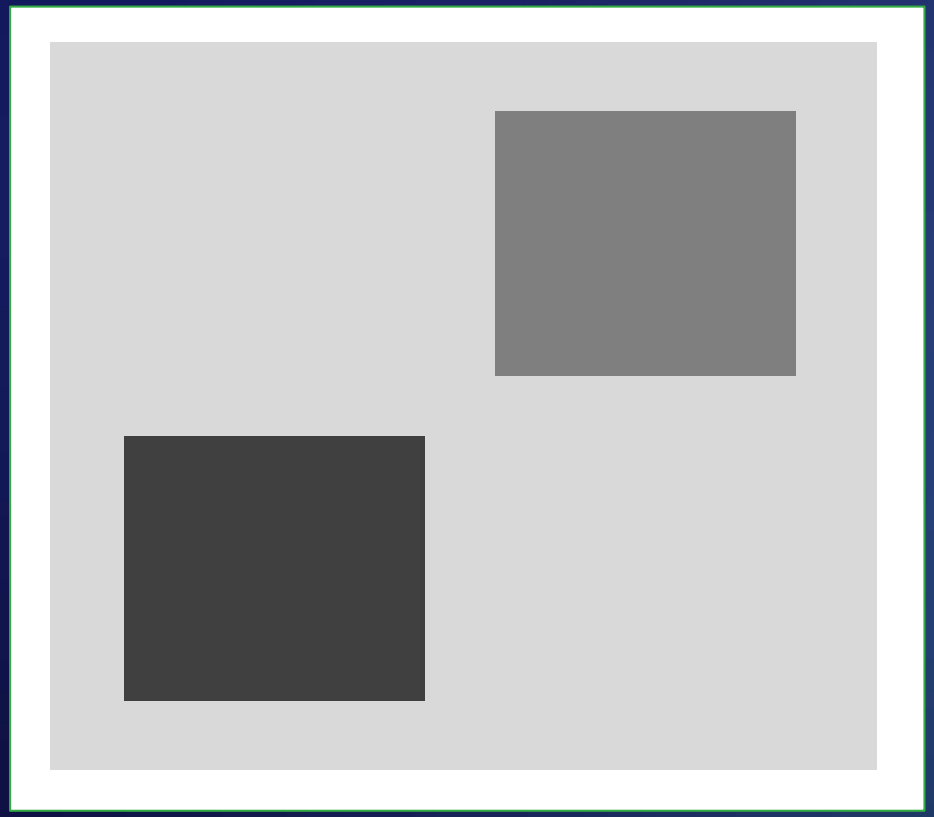
100
10,000
1,000,000

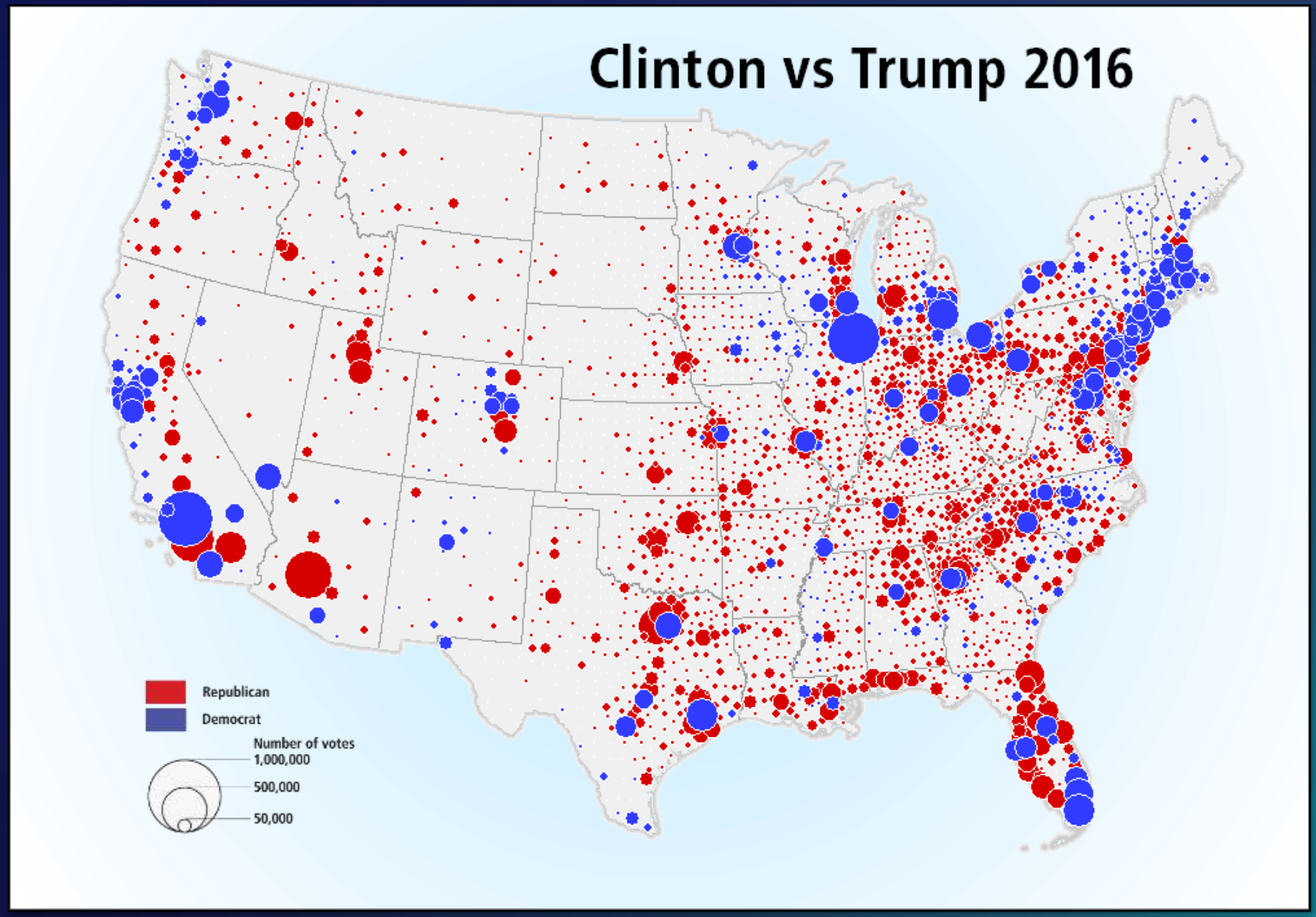
Democrat

100
10,000
1,000,000

CITIES
STATES

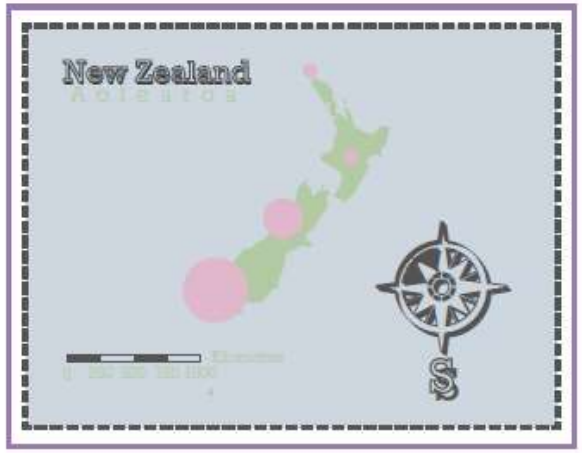
Hierarchy, contrast and figure-ground




Clinton vs Trump 2016
Republican
Democrat
Number of votes
1,000,000
500,000
50,000

Better hierarchy

Poorer hierarchy



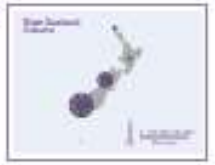
Better hierarchy greyscale

Poorer hierarchy greyscale

Better hierarchy squint

Poorer hierarchy squint

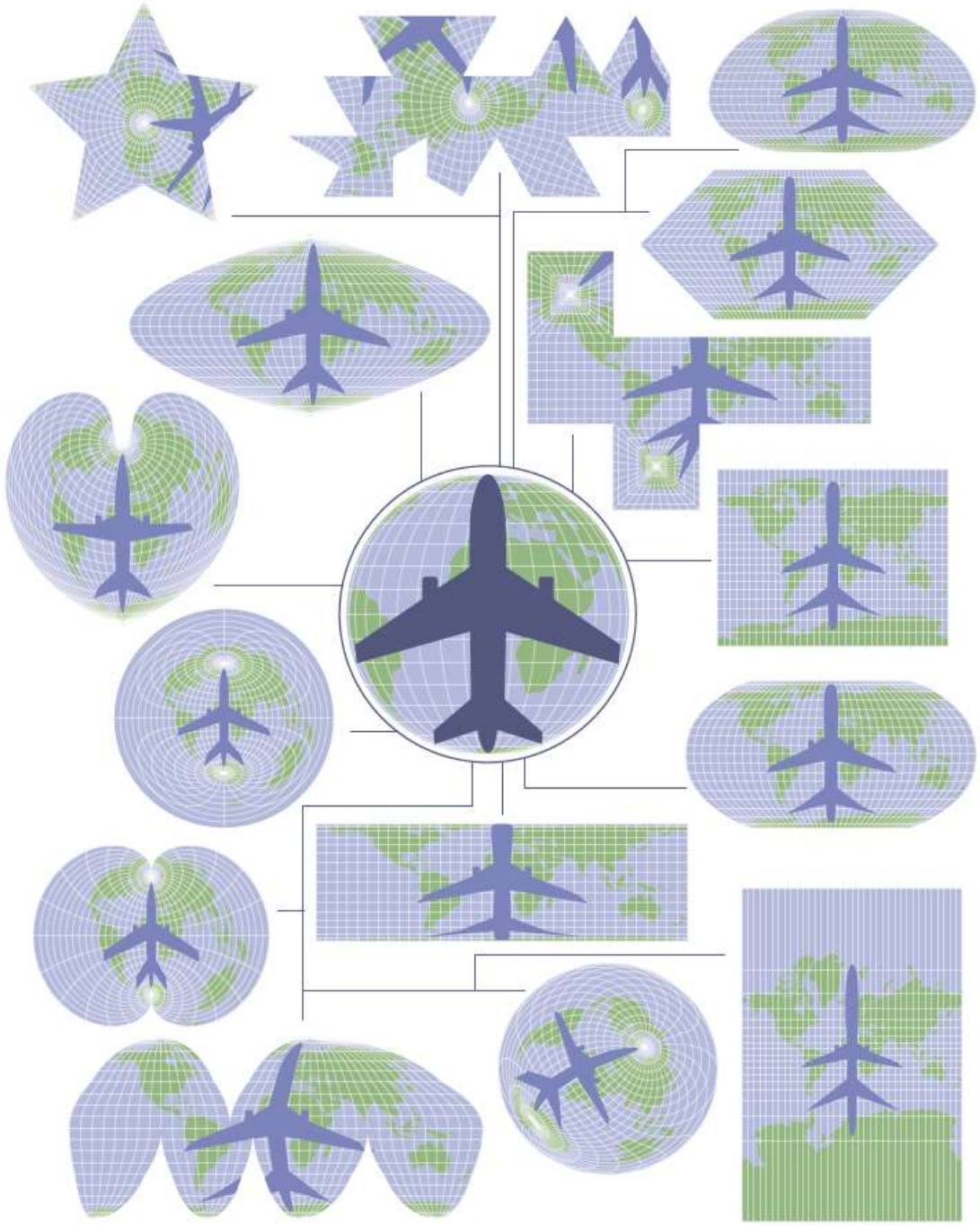
Better hierarchy small



Poorer hierarchy small

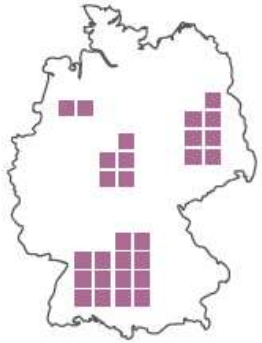
Wes, what's hierarchical in the map?

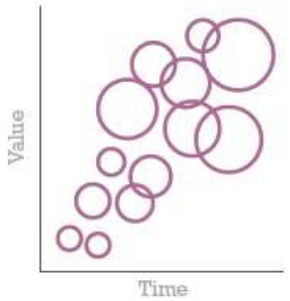
Design projections

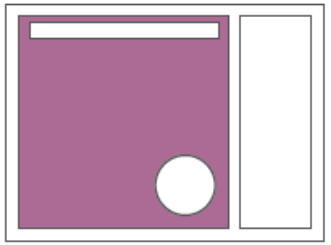


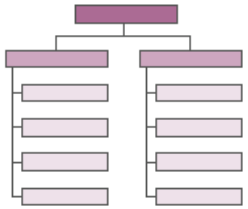
Wes, have you considered projections?

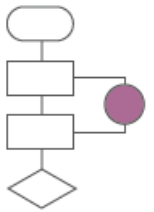
Design symbols



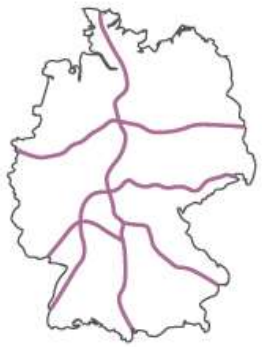


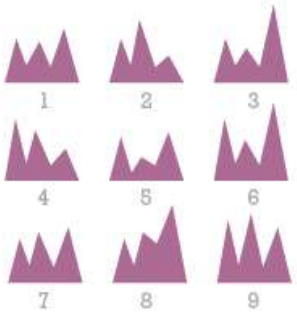






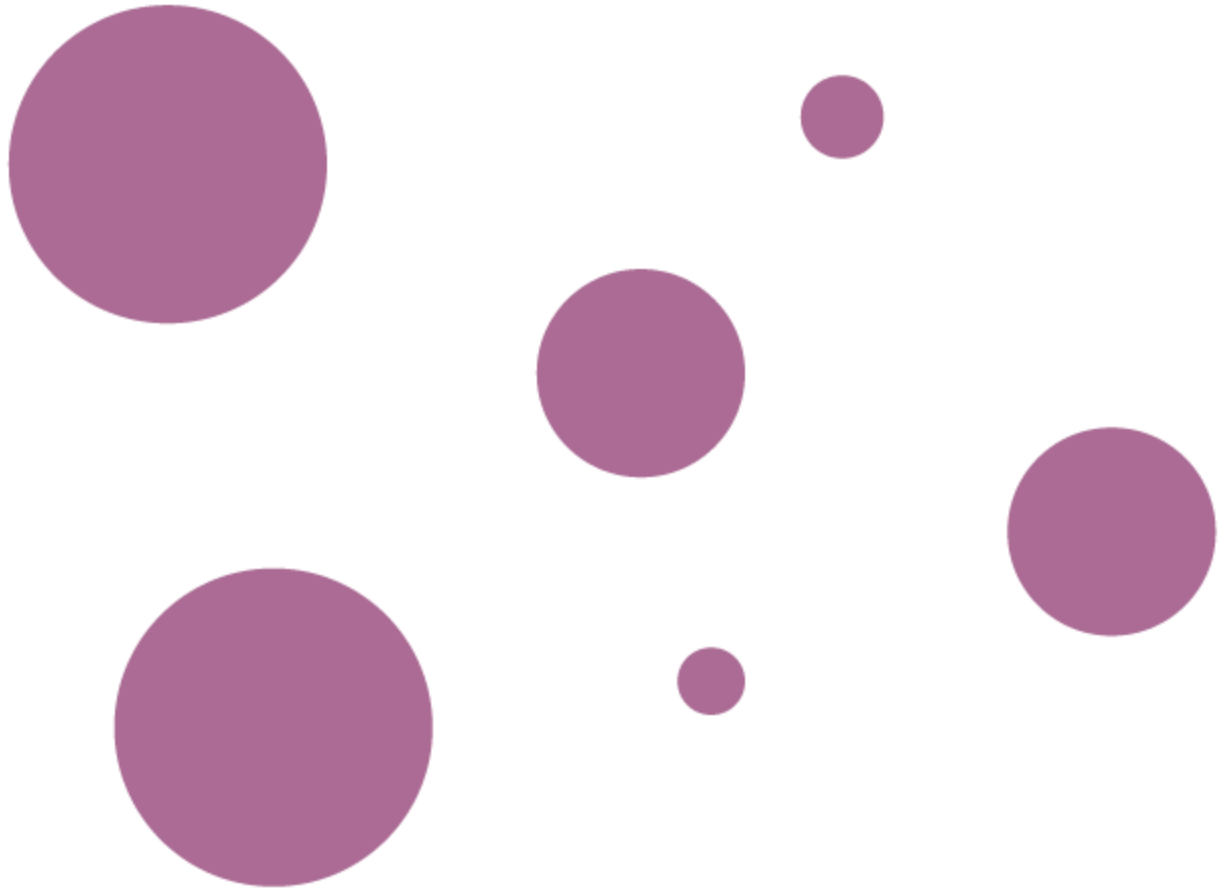
	52	83	13
	48	62	16





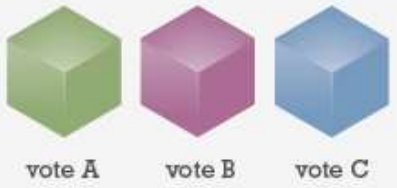
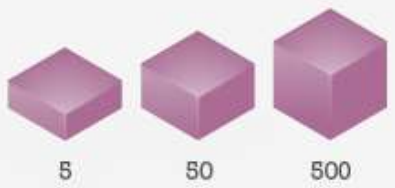
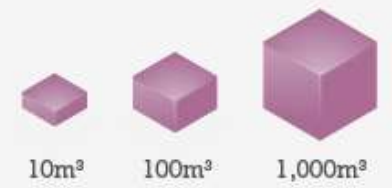
During the 1975-1993 Brian Clough years, Nottingham Forest went from champions 1st 22nd to relegation.

During this period they won and were runners-up. They went 42 games unbeaten between Nov 1977 and Dec 1978, a record that stood until 2004.



Feature dimension	Encoding	Qualitative	Quantitative		
		Nominal (difference)	Ordinal (ranked)	Interval (quantity, value)	Ratio (proportional, relative)
Literal (words, numbers)	Single	airport, stadium, factory	small, medium, large	5 ton 100 people 20 births	5 ton per sq km 100 people per minute 1.2 births per family
	Multiple	City *River* Monument	**CITY** Town Village	**Nottingham** 100k—500k Newark 10k—99k Stapleford 0—9k	**Nottingham** 311,500 people Newark 27,700 people Stapleford 1,979 people
Point (geometric, pictorial)	Single	Shape airport, emergency phone, picnic site	Crispness low, medium, high	Value < 19, 20—29, 30+	Size 50%, 75%, 100%
	Multiple	Shape & Hue international airport, regional airport, airport (disused)	Size & Hue small, medium, large train, boat, plane	Shape & Value 170, 65, 130	Hue & Arrangement units sold 2x, 4x 1st quarter, 2nd quarter

Feature dimension	Encoding	Qualitative	Quantitative		
		Nominal (difference)	Ordinal (ranked)	Interval (quantity, value)	Ratio (proportional, relative)
Line	Single	Shape & Hue road railway river	Shape, Size & Hue motorway main road (dual) A road B road track	Size 10 vehicles 10 vehicles 10 vehicles	Size & Transparency 1 per hour 4 per hour 8 per hour
	Multiple	Shape & Value railway abandoned railway	Orientation steep incline moderate incline no incline	Shape, Orientation & Size 45 miles W by air 70 miles E by road	Size & Orientation base speed 2x speed 4x speed
Area	Single	Shape & Hue lake building forest	Resolution smallest medium largest	Saturation 500 1,000 2,000	Size 25% 75% 100%
	Multiple	Hue, Shape & Arrangement	Size	Size & Transparency	Value

Feature dimension	Encoding	Qualitative	Quantitative		
		Nominal (difference)	Ordinal (ranked)	Interval (quantity, value)	Ratio (proportional, relative)
Volume		Hue 	Transparency	Height 	Size 

Wes, how did you design the symbols?

Design generalisation

Feature generalization

1:147,914,382

1:577,791

1:72,224

Large scale

Small scale

1:18,489,298

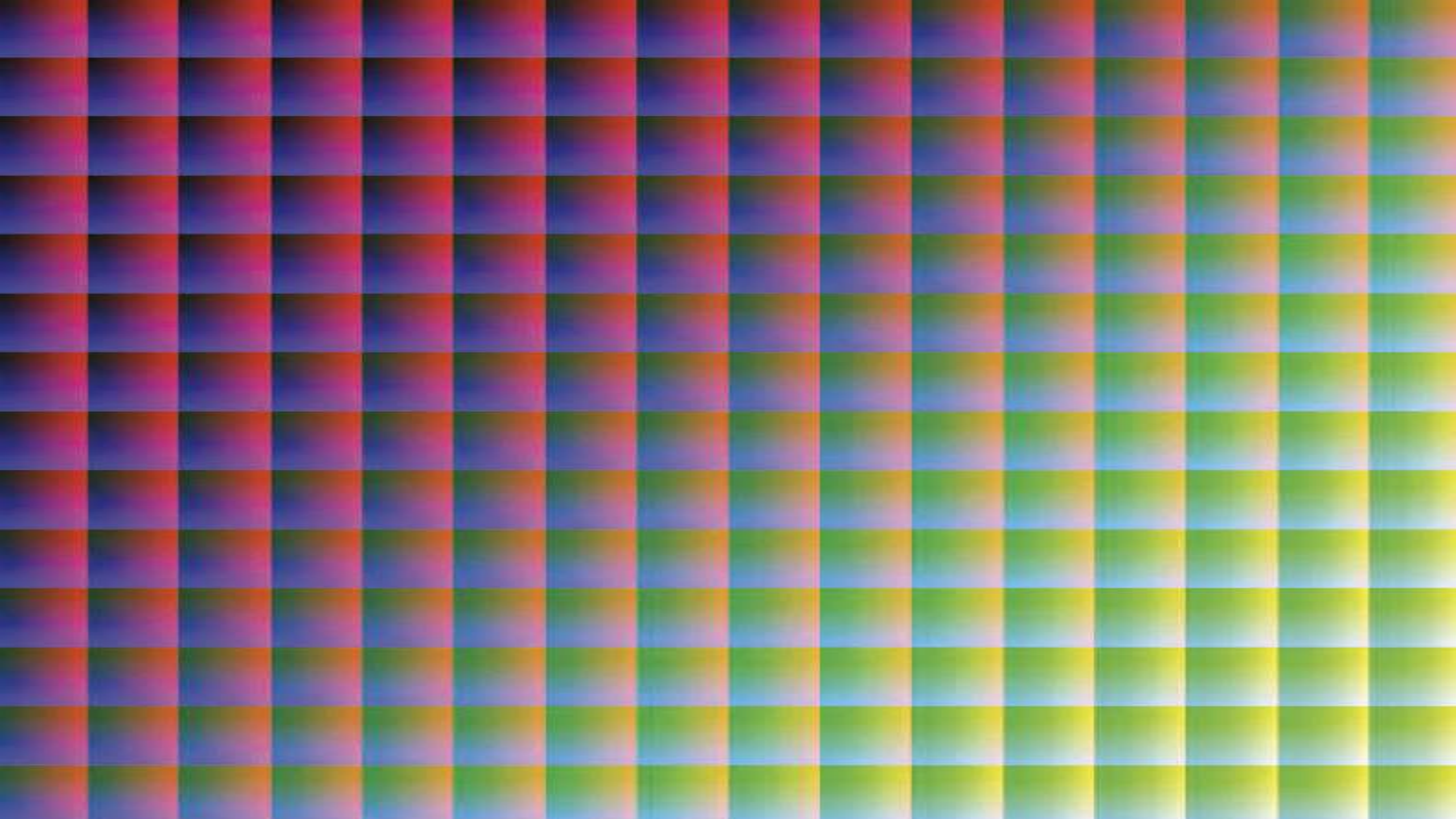
1:144,448

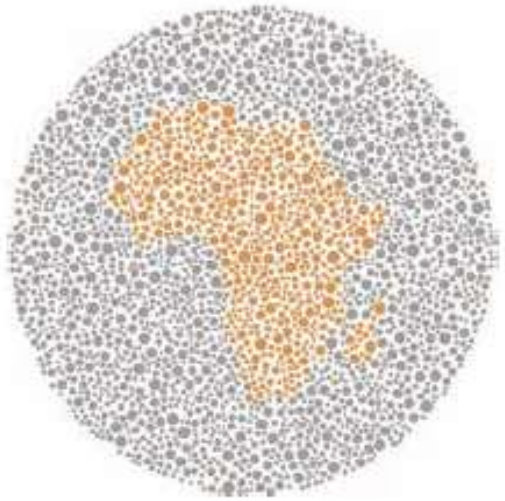
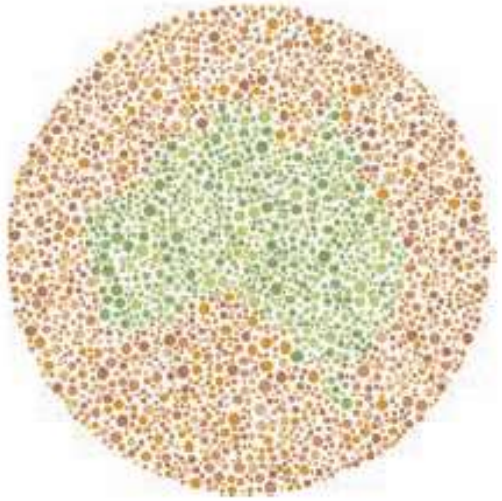
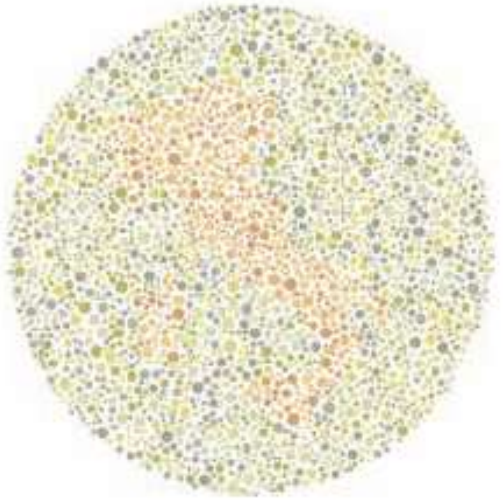
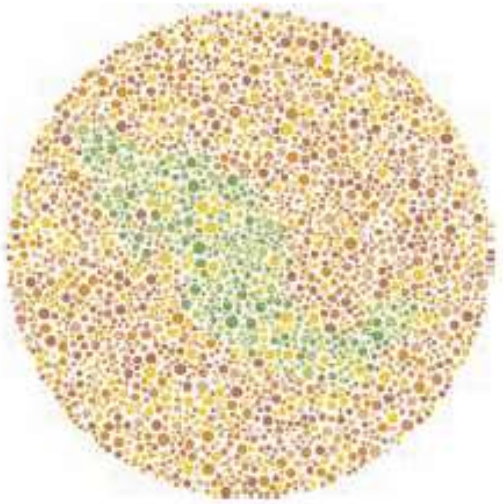
1:4,514

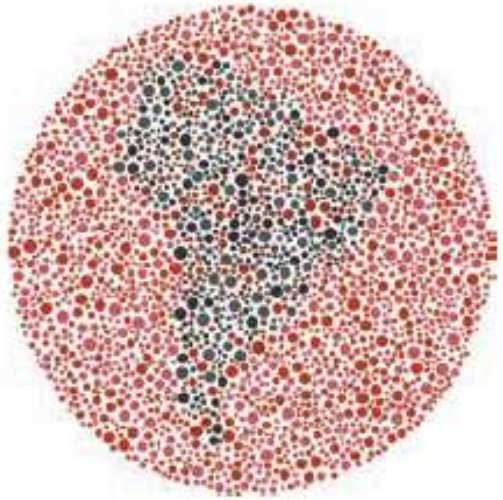
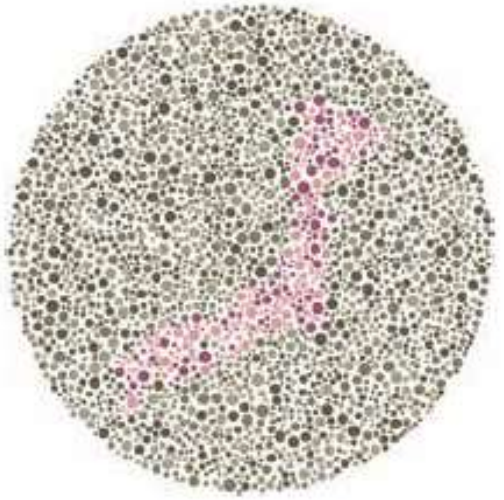
Generalisation Wheel
A Cartographer's Generalisation Palette

Wes, how about generalisation?

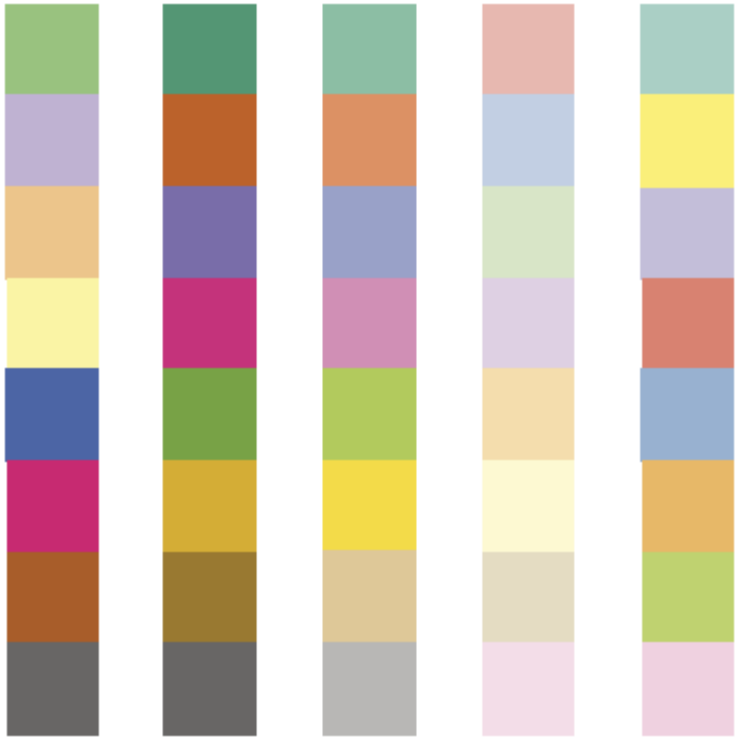
Design colour



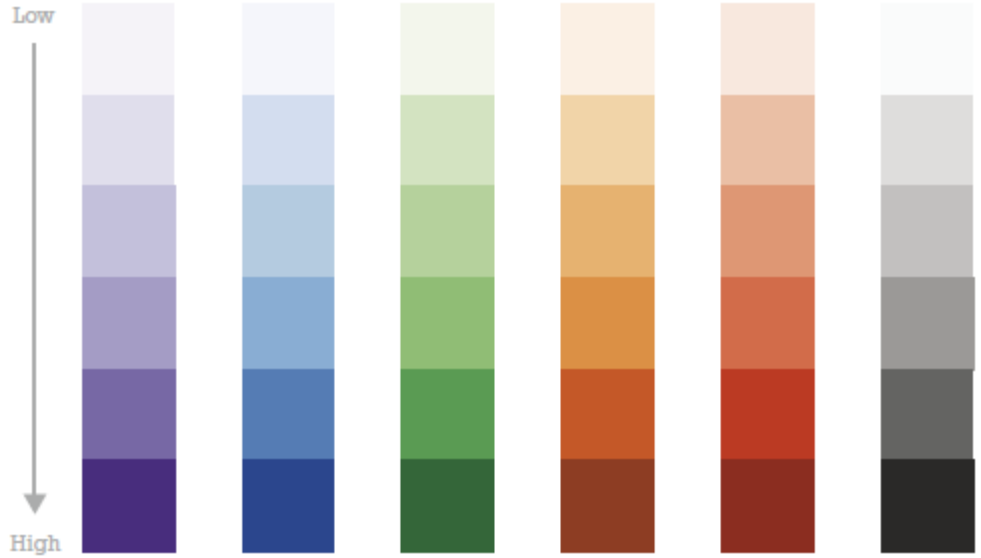





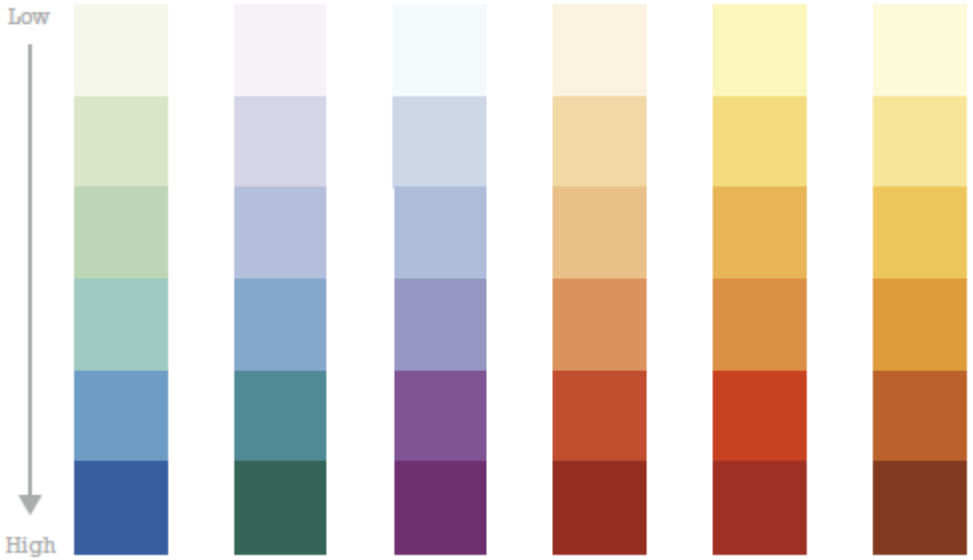
Qualitative

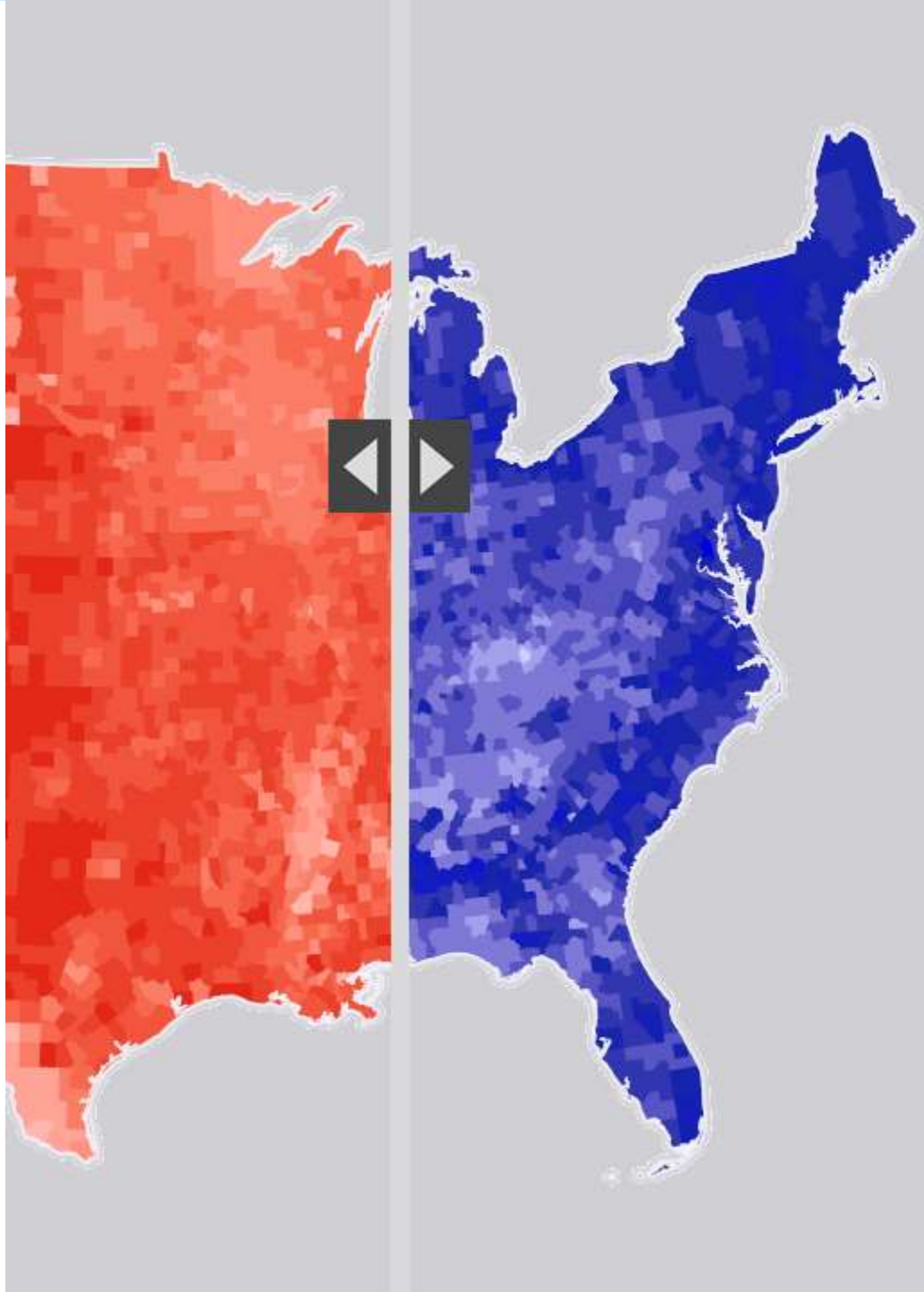


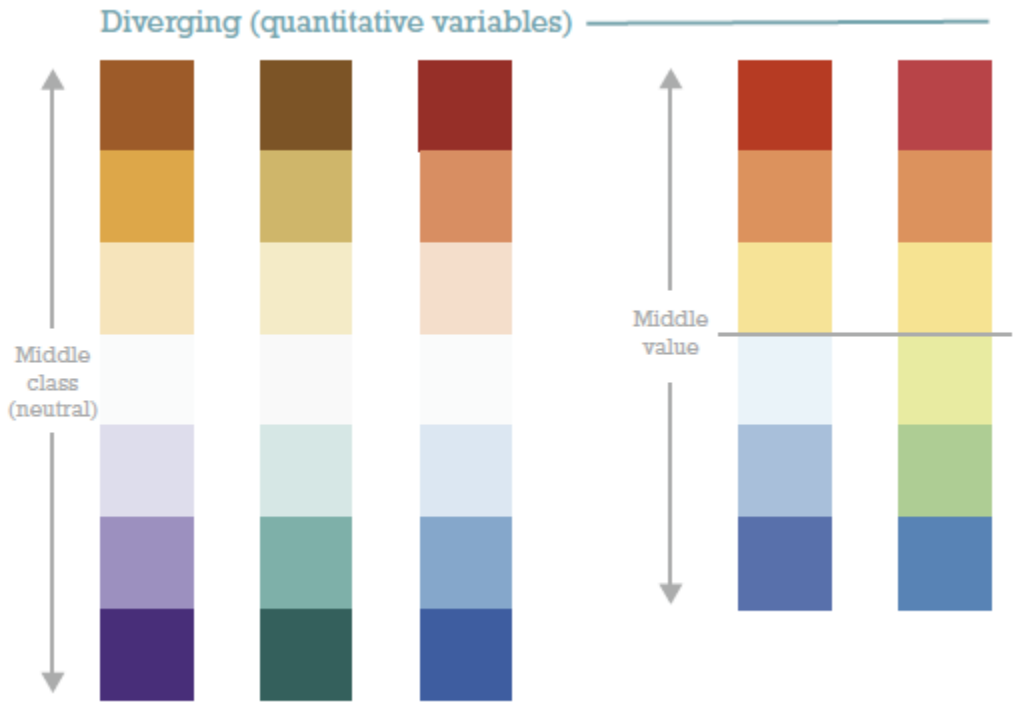
Sequential (quantitative variables)

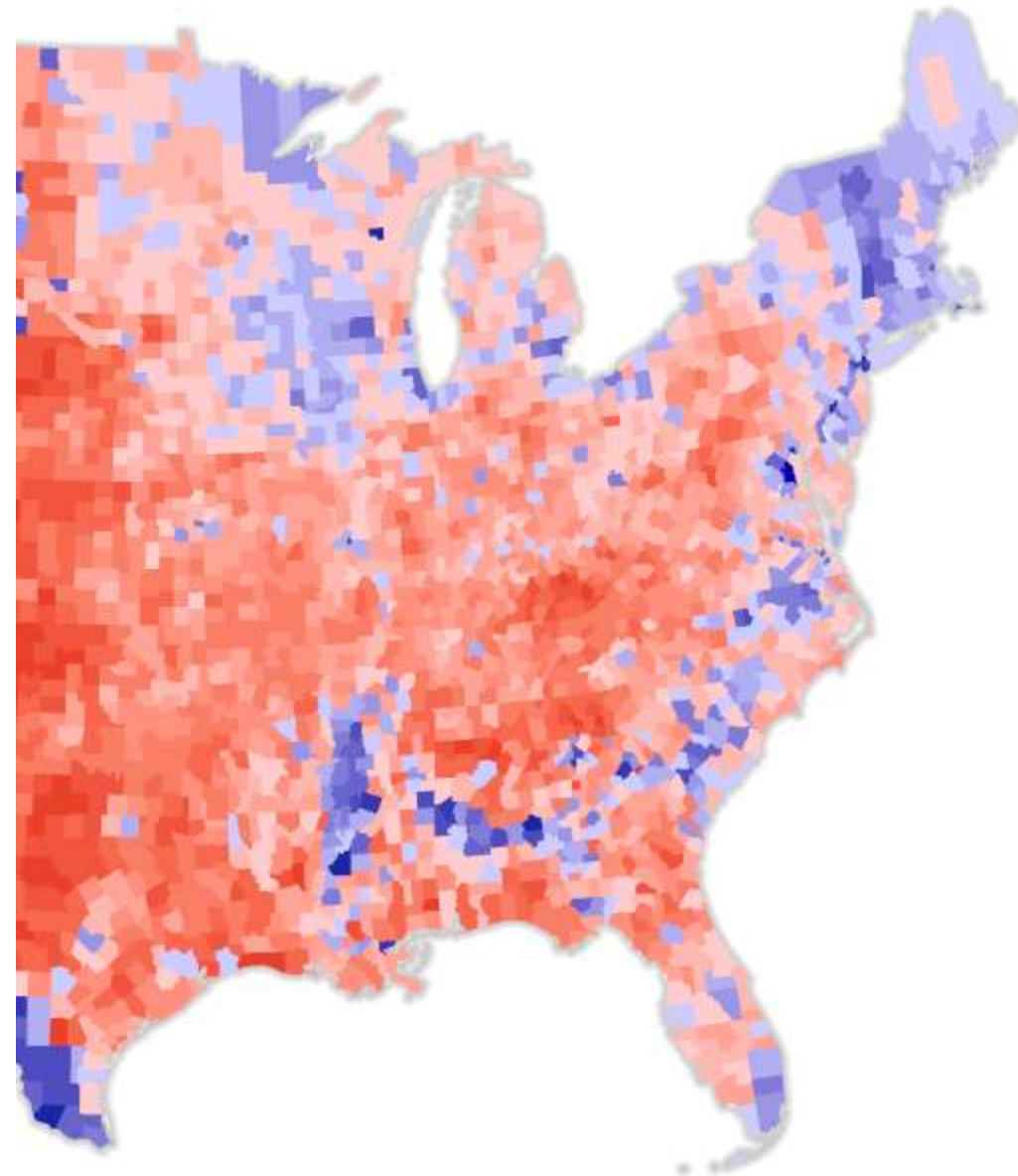


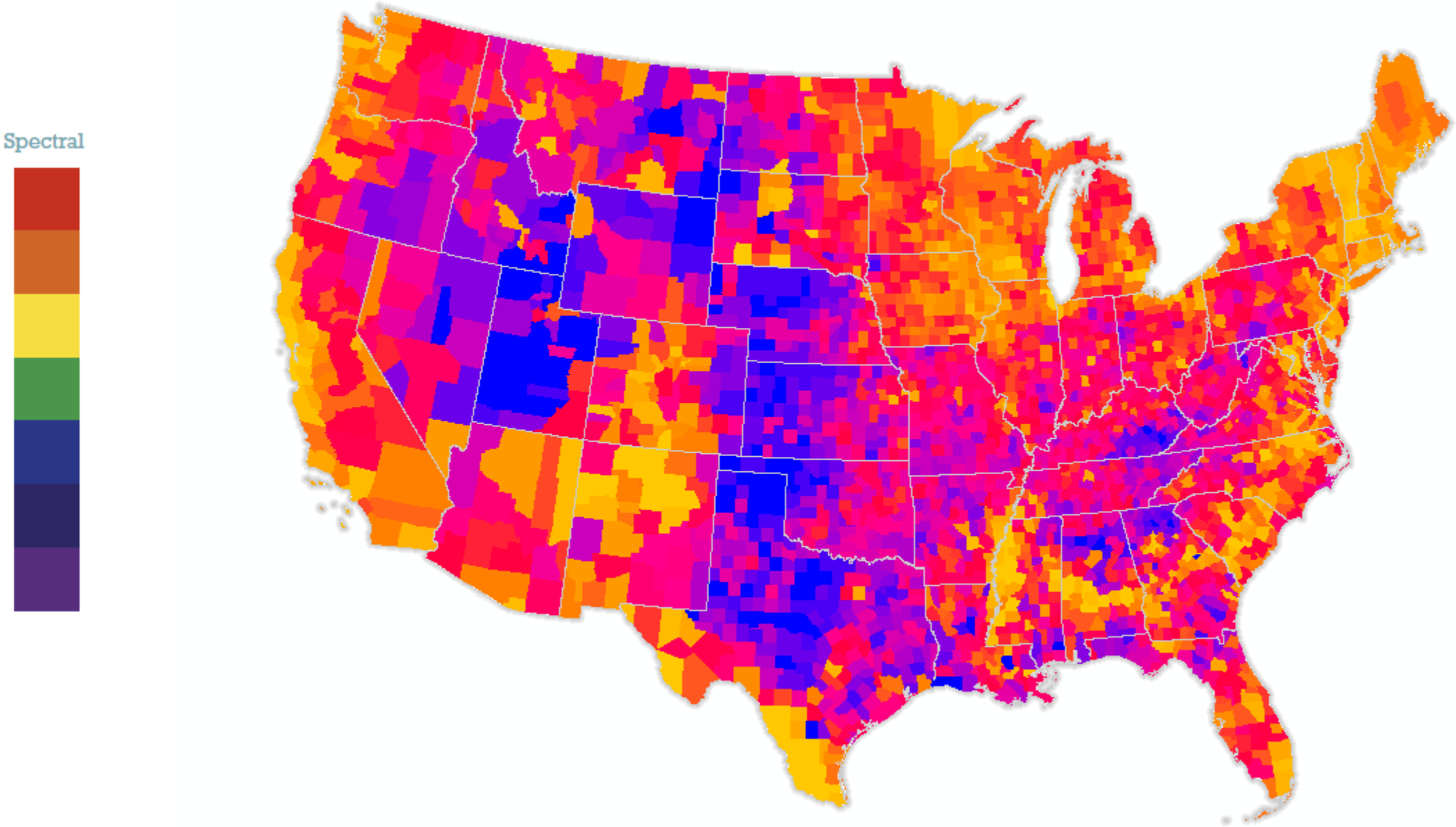
Sequential with hue transition (quantitative variables)

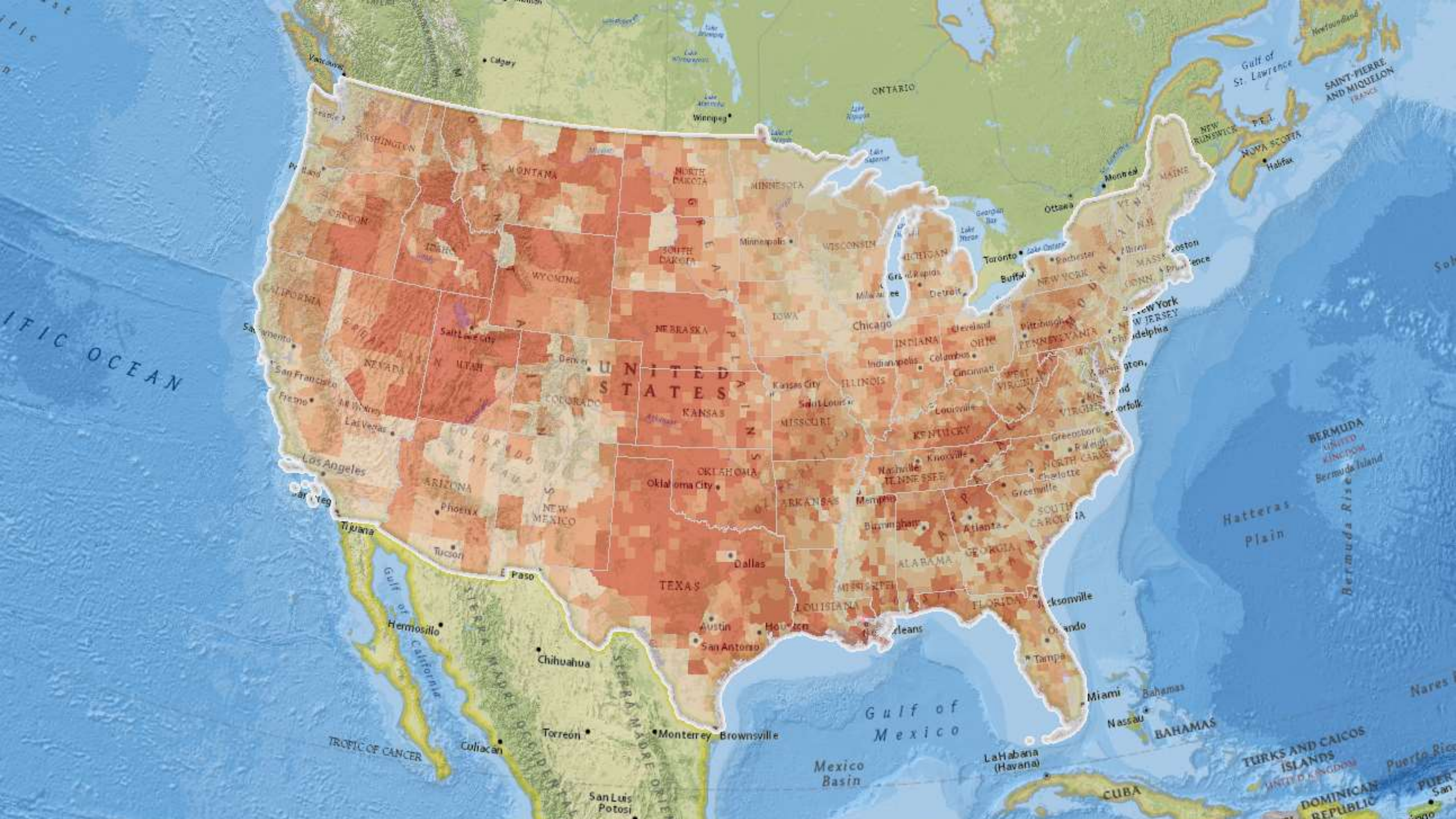





Diverging (quantitative variables)
Middle class (neutral)
Middle value

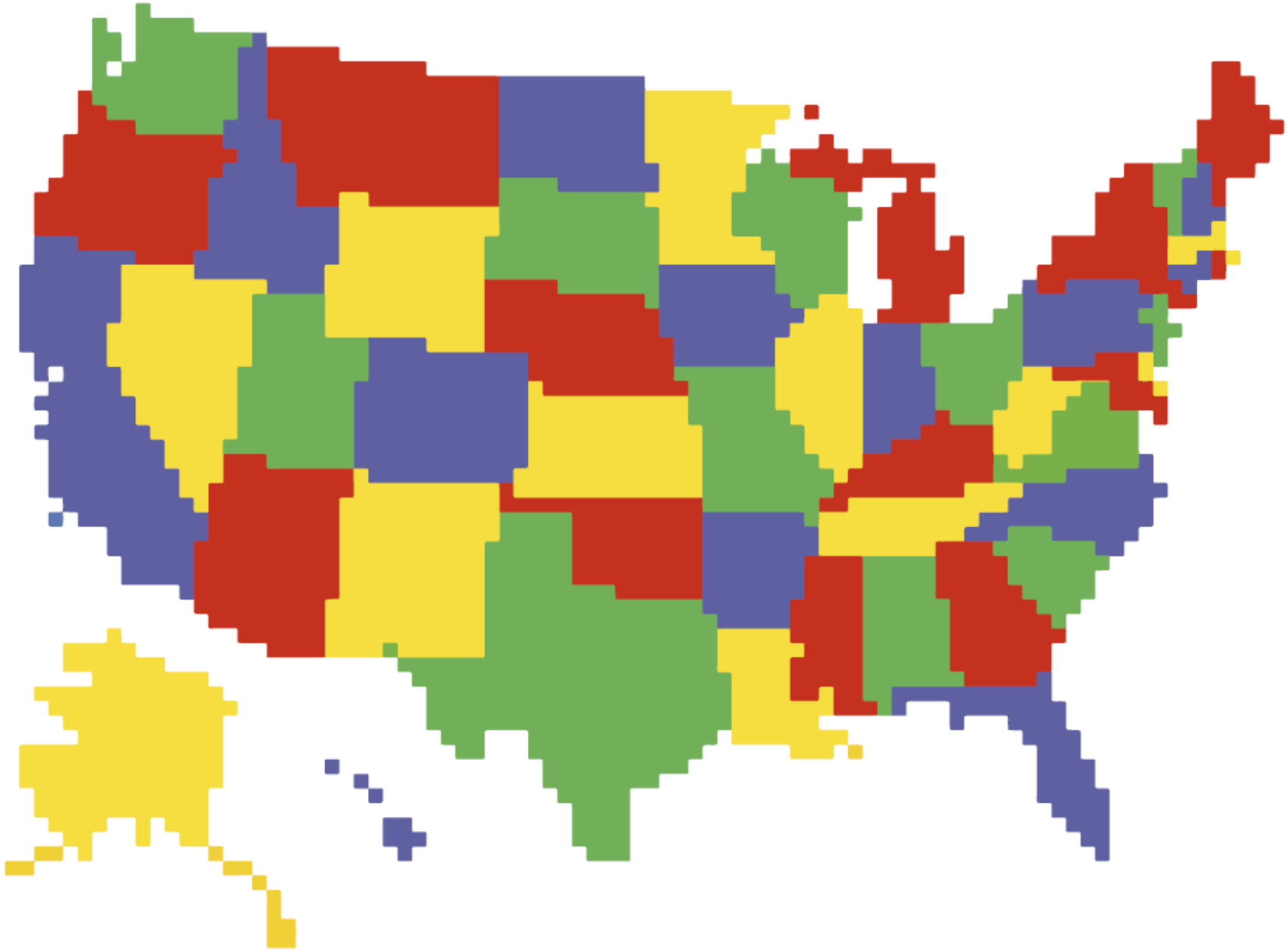



Spectral


UNITED STATES
Gulf of Mexico
Mexico Basin
Hatteras Plain
PACIFIC OCEAN
Vancouver
Calgary
Winnipeg
ONTARIO
Gulf of St. Lawrence
Newfoundland
SAINT-PIERRE AND MIQUELON
NEW BRUNSWICK
P.E.I.
NOVA SCOTIA
Halifax
Montreal
Ottawa
Toronto
Buffalo
Rochester
Boston
MAINE
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
NEW JERSEY
Minneapolis
Chicago
Detroit
Cleveland
Pittsburgh
Indianapolis
Columbus
Cincinnati
Kansas City
Saint Louis
Louisville
Nashville
Knoxville
Greensboro
Raleigh
Charlotte
Greenville
Memphis
Birmingham
Atlanta
Jacksonville
Orlando
Tampa
Miami
Bahamas
Nassau
BAHAMAS
Salt Lake City
Denver
Oklahoma City
Dallas
Austin
Houston
San Antonio
New Orleans
Phoenix
Tucson
Las Vegas
Los Angeles
San Francisco
Sacramento
Fresno
El Paso
Tijuana
Hermosillo
Chihuahua
Torreon
Monterrey
Brownsville
Culiacan
San Luis Potosi
TROPIC OF CANCER
Gulf of California
Sierra Madre Occidental
Sierra Madre Oriental
Colorado Plateau
Great Basin
LaHabana (Havana)
CUBA
TURKS AND CAICOS ISLANDS
DOMINICAN REPUBLIC
Puerto Rico
BERMUDA
Bermuda Rise
Bermuda Island

Four colour

Four-colour theorem applied to the United States. No two adjacent States have the same colour which creates a well balanced distribution of colours across the map



Wes, how have you used colour?

Design typography

Use	Description and Use
Descriptive text	Reflects features that are symbolised on map by point, line, area
Narrative	Names of objects
Descriptive	Additional property of feature (e.g. scenic route)
Warning	Dangerous nature of feature (e.g. sunken wreck)
Functional	Locatable ground feature (e.g. rescue post)
Regulatory	Legal information (e.g. area of land)
Analytical text	Links user with attribute of features
Confirmative	Spatial relations (e.g. distance between features or bearings)
Determinative	Tables placed alongside map
Interpretive	Difficult to get information from a map so provided (e.g. quickest route is…)
Reference	Text alongside map
Categorisation	Categorisation of a theme in codes (e.g. geological codes)
Positional Text	Text to describe or confirm location, in space or time
Geocoding	Grid reference positions
Measurement	Relative position (e.g. at edge of map, 20 miles to…)
Temporal Position	Text to give time of events (e.g. historic battles)
Metadata	Refer to the nature of source data to map as a whole (e.g. reference ellipsoid)

Rockwell

ABCDEFGHIJKLMNOPQRS
TUVWXYZabcdefghijklmn
opqrstuvwxyz1234567890.

REGULAR *ITALIC* **BOLD**

Futura

ABCDEFGHIJKLMNOPQRS
TUVWXYZabcdefghijklmn
opqrstuvwxyz1234567890.

REGULAR *ITALIC* **BOLD**

Garamond

ABCDEFGHIJKLMNOPQRS
TUVWXYZabcdefghijklmn
opqrstuvwxyz1234567890.

REGULAR *ITALIC* **BOLD**

Lucida Sans

ABCDEFGHIJKLMNOPQRS
TUVWXYZabcdefghijklmn
opqrstuvwxyz1234567890.

REGULAR *ITALIC* **BOLD**

Times New Roman

ABCDEFGHIJKLMNOPQRS
TUVWXYZabcdefghijklmn
opqrstuvwxyz1234567890.

REGULAR *ITALIC* **BOLD**

Comic Sans

ABCDEFGHIJKLMNOPQRS
TUVWXYZabcdefghijklmn
opqrstuvwxyz1234567890.

REGULAR *ITALIC* **BOLD**

ASIA

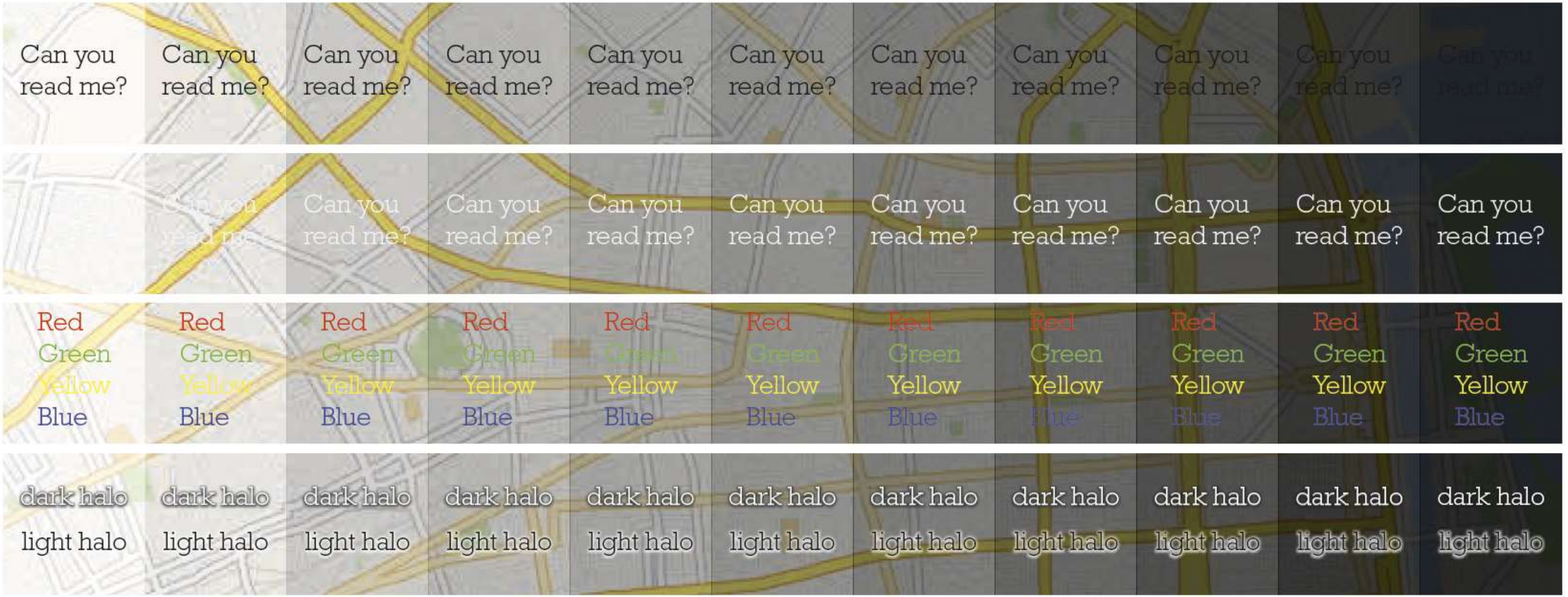
PACIFIC OCEAN INDIA CHINA Ocean Country

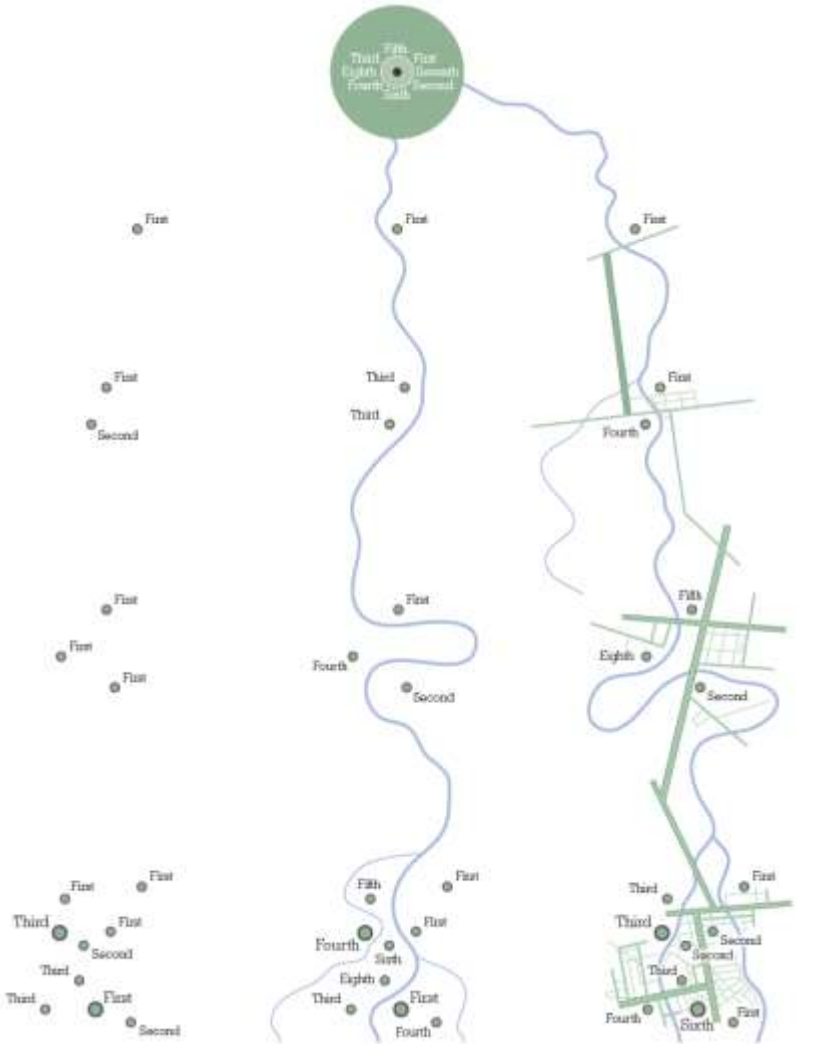
Kara Sea *Sea of Okhotsk* Rajasthan Sichuan Irkutsk Punjab Sea Province

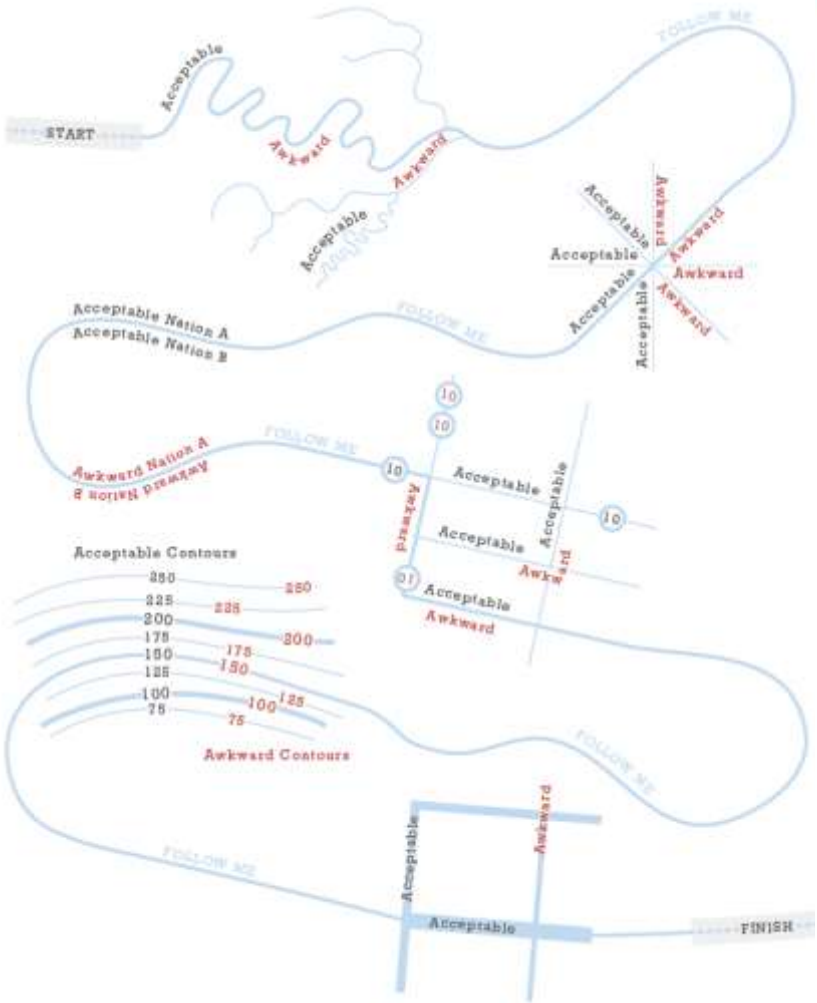
Korea Bay *Gulf of Thailand* *Ob Bay* Beijing Tokyo Mumbai Karachi Bay Major City

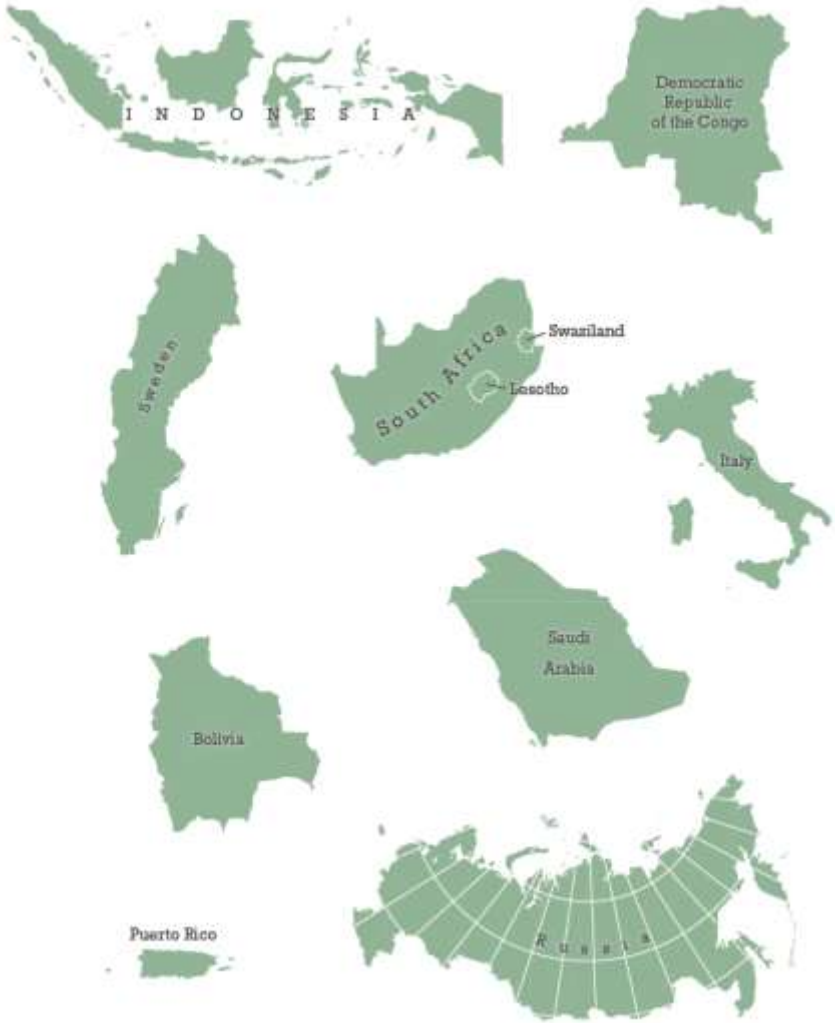
Lake Baikal *Lake Balkhash* *North Aral Sea* Morioka Taraz Akola Guilin Vladivostok Keelung Lake City

Ob *Lena* *Amur* *Yangtze* *Ganges* *Irrawaddy* *Tigris* Aksay Berdsk Turbat Sircilla Udala Pyu River Town


Can you read me?
Red
Green
Yellow
Blue
dark halo
light halo


First
Second
Third
Fourth
Fifth
Sixth
Seventh
Eighth


START
FINISH
Acceptable
Awkward
FOLLOW ME
Acceptable Nation A
Acceptable Nation B
Awkward Nation A
Awkward Nation B
Acceptable Contours
350
325
300
275
250
225
200
175
150
125
100
75
Awkward Contours
10

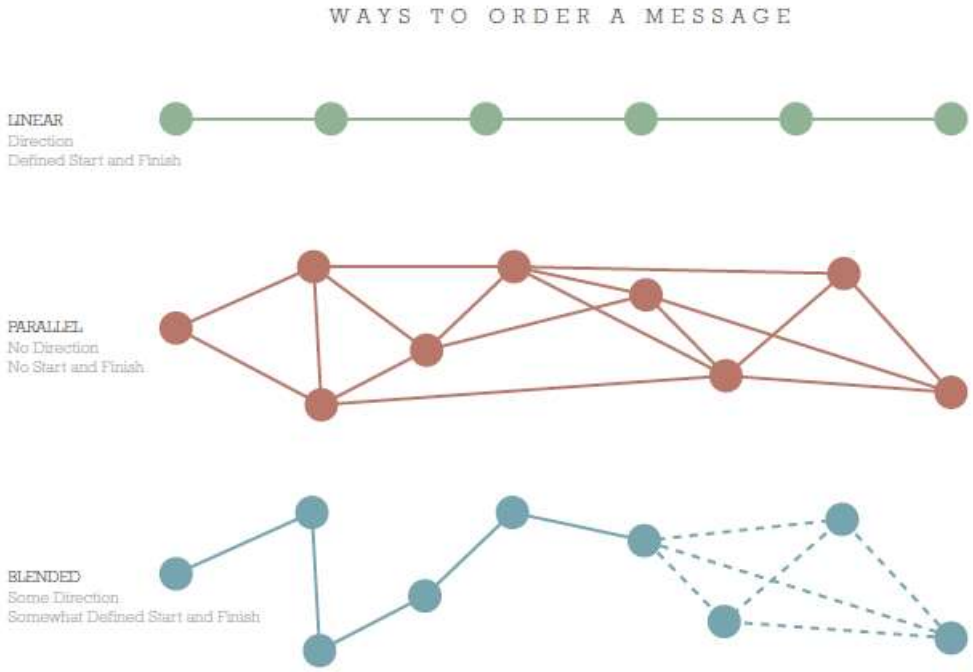

INDONESIA
Democratic Republic of the Congo
Sweden
South Africa
Swaziland
Lesotho
Italy
Saudi Arabia
Bolivia
Puerto Rico
Russia

Wes, how have you designed the lettering?

Comic Sans walks into a bar

Barman says
“sorry, we don’t serve your type”

Design layout



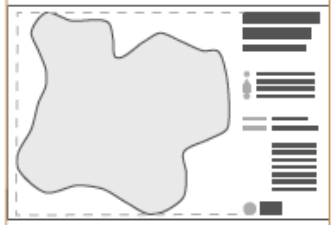
Skeletal grid column

Title and subtitle at top

All marginalia beneath the map

Map bleeds off page, detail in a column

Map shape, detail in a column



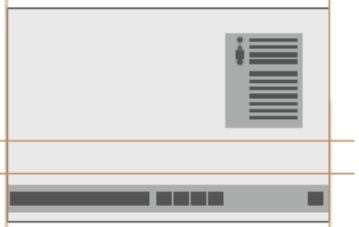
Interval grid column

Map shape, detail around

Web map, marginalia in drop-down

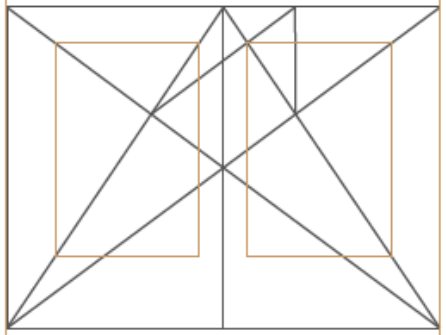
Web map, marginalia in pop-outs

Web map, click, hover, floating pop-ups



Web map, storytelling template

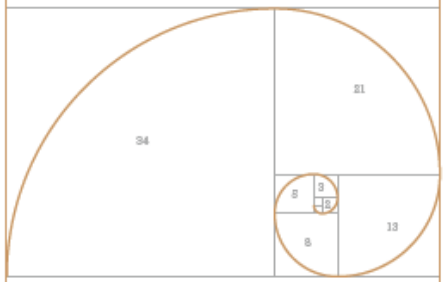
Golden ratio



Golden spiral

a = 42.39mm b = 26.2mm

$$\frac{a}{b} = \frac{a+b}{a} = 1.618$$



In mathematics a Fibonacci number sequence is that where each number is the sum of the preceding two numbers:

1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, ...

The golden spiral is based on an approximation of the sequence of Fibonacci numbers which equate to length of the edges of successive squares. This creates identically proportioned rectangles, each of which has a ratio of 1.618 of the length of the long side to that of the short side.

Mapped area: the map itself comprising symbolised points, lines, and areas and typographic components, possibly with the use of imagery.

Inset/locator map: showing the larger mapped area in context or detail of a small part of the mapped area.

Title and subtitle: the wording that communicates the theme of the map.

Neatline, frame, or border: a line that bounds the active map area, frequently constructed from lines of an underlying graticule or grid.

Graticule: lines of parallels of latitude and meridians of longitude.

Grid lines: a reference grid unrelated to latitude or longitude.

Graticule or grid line labels: specifying coordinates in degrees or map units.

Margin: an area between the active map and the edge of the display, sometimes literally used to contain marginalia on map sheet series.

Scale: a statement of the distance range of the map, graphical or a verbal statement, often not required on small-scale thematic maps or where scale differs across the map because of coordinate system or perspective.

Legend: list of symbols and their descriptions used to assist map interpretation.

Orientation: a north arrow or other similar symbol to orient the viewer to the map, often unnecessary if a graticule is included or for thematic maps or where the coordinate system means north varies across the map.

Source: statement of the origin of data

Copyright: statement of permissions granted or of the copyright holder of the map.

Map series legend: used if the map is part of a sheet series.

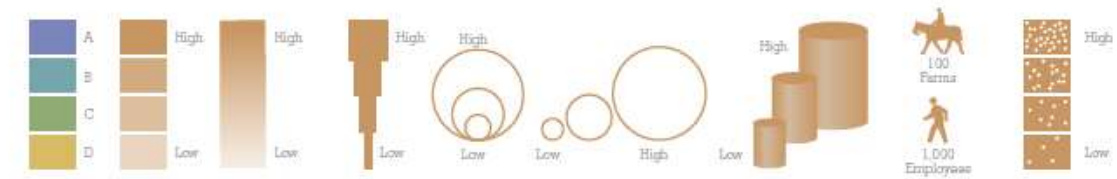
Text blocks: description and/or statements of datums and coordinate systems used or of the date of data and revisions.

Author details: a statement on who made the map helps give it authority.

Features Key

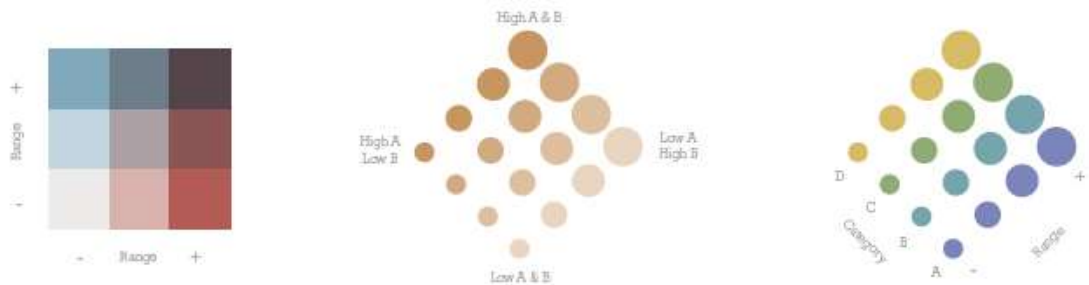
Category Class Physiographic

Thematic ~~Legends~~



Categorical Discrete Continuous Graduated Representative Density

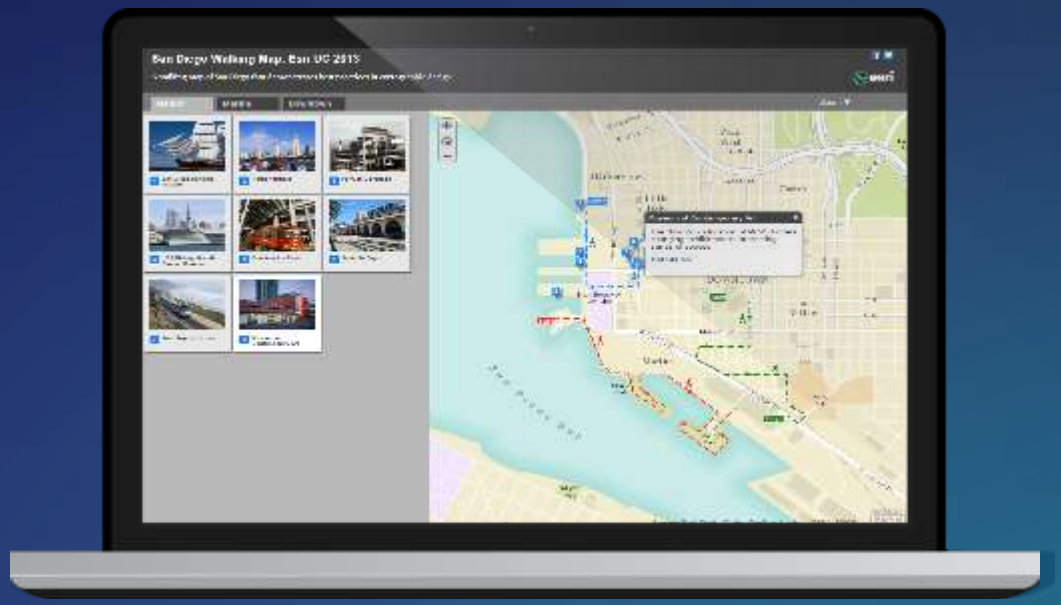
Multivariate Legends



Multipurpose Legends

Title as Legend Chart as Legend

San Diego Walking Map
Little Italy
Harborview
Core-Columbia
DOWNTOWN
Broadway
Horton Plaza
Gaslamp
East Village
Cortez
Marina
Meters
Legend
Downtown walk
Marina walk
Museums walk



Wes, how did you design the layout?

Critique (review)

A checklist can help with critique and review

Map Evaluation Checklist

Questions to consider when performing map critique

Name of author

Date of evaluation

Title of map

Map sheet (if in a series)/URL

Cartographic Requirement

What is the rationale for the map?

What is the purpose of the map (i.e. the substantive objective)?

What is the "look and feel" of the map (i.e. the affective objective)?

Who is the audience for the map?

What is the expected educational level of the audience for the map?

What are the expected conditions of use for the map (medium, distance, light, etc.)?

Cartographic Compilation and Design

Have all required themes and features been included?

Does the map have appropriate figure-ground organisation?

Is there appropriate visual hierarchy among all themes and within each theme?

Is there appropriate visual emphasis on the important theme(s)?

Is the symbology for qualitative and quantitative data effectively applied?

Do the colours and symbols support the substantive and affective objectives?

Do the font styles, size, and colour support the substantive and affective objectives?

Are the symbols and labels legible?

Are the symbols intuitive and easy to decipher or do they have good explanation?

Is there appropriate use of graphics, images, text blocks, and other supporting information?

Can the map be placed in context both geographically and thematically?

Is the map projection suited to the map's purpose (equal area, conformal, etc)?

Has the map projection been appropriately modified (central meridian, standard parallels, etc.)?

Map Elements and Page Layout

Does the page look balanced?

Do all the map elements support the substantive and affective objectives?

Are the map elements placed logically on the page?

Are the map and map elements aligned to the page and to each other?

Does the map have appropriate borders?

Orientation Indicator

Is the grid or graticule appropriately aligned?

Does the grid or graticule have appropriate labeling?

Does the map require a north arrow?

Scale Indicator

Is the scale appropriate to the map?

Is the scale bar appropriately designed, positioned, and sized?

Are the scale units logical?

Legend

Have all the necessary symbols and details been included in the legend?

Do the symbols in the legend appear exactly as they do on the map (size, colour, etc.)?

Is there a logical structure related to the function of the legend?

Are the patches, symbols, labels, and descriptions appropriately sized and positioned?

Are the labels logical?

Titles and Subtitles

Are the titles and/or subtitles relevant?

Are the titles and/or subtitles suitably descriptive (area mapped, subject, date, etc.)?

Are the titles and/or subtitles suitably positioned and sized?

Production Notes

Are production notes included?

Are the production notes dated correctly?

Are the production notes placed appropriately?

Have copyrighted sources been correctly attributed?

Has the map's assertion to copyright been included?

Have attribution and/or revision details been included?

Synopsis and Final Check

Given your responses to the above, provide an overall evaluation of the extent to which the design of the map meets its intended aims. You might also include here comments made by independent reviewers of the map as a new perspective that often reveals areas that the map author may have overlooked.

The Four Point Plan

Comment on four areas that work well and four that might require attention.

What works well?	What doesn't work so well?

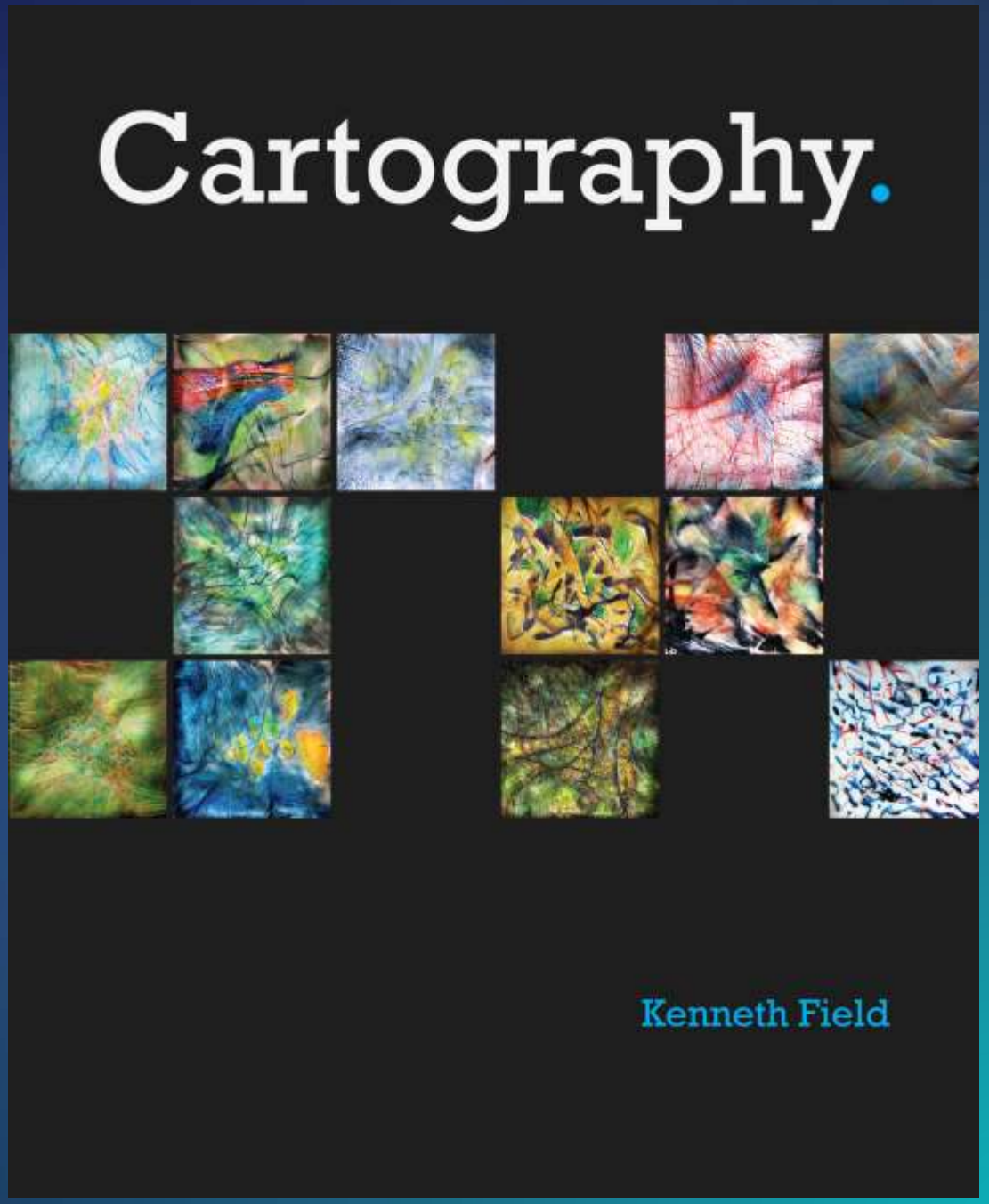
One more thing

Actually…a few more things

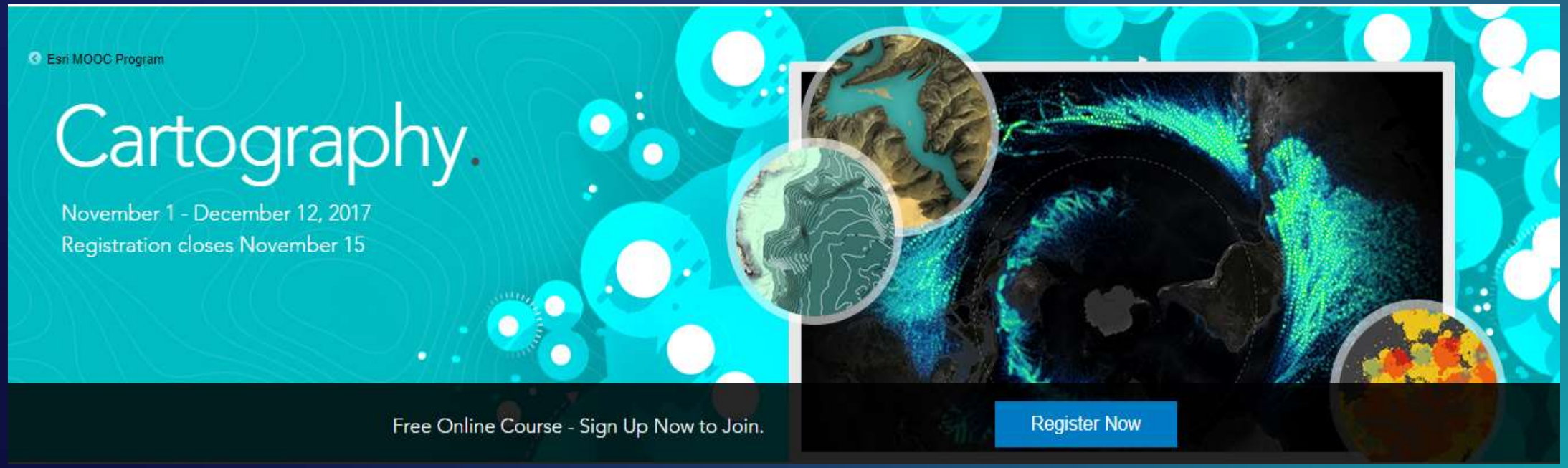
The book

In the UC store

esripress.esri.com



The MOOC
esri.com/mooc/cartography (Sep 5th 2018)



The URLs

esri.com/arcgis-blog

carto.maps.arcgis.com

cartonerd.com

adventuresinmapping.com

mapdesign.icaci.org

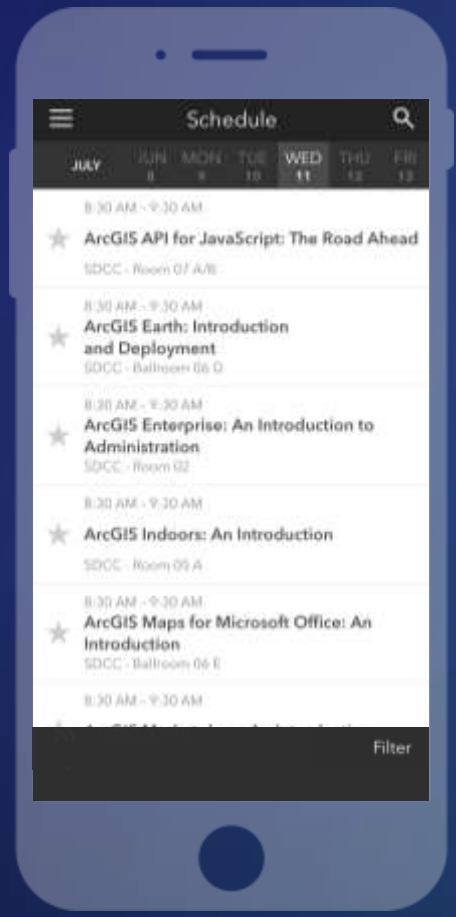
Other sessions

How to Make a Great Map (Ken Field/Wes Jones)	**Tue 14:30 | Thu 14:30**
Amazing and Inspiring maps (Ken Field/John Nelson)	**Wed 10:00 | Thu 10:00**
Creating Thematic Maps (Ken Field/John Nelson)	**Wed 08:30 | Thu 13:00**
3D Cartographic Techniques (Nathan Shephard/Ken Field)	**Tue 13:00 | Wed 16:00**
Map Design for Representing Relief (Ken Field/John Nelson)	**Wed 14:30 | Thu 08:30**
ArcGIS Pro: Mapping and Visualisation (Edie Punt/Craig Williams)	**Tue 14:30 | Wed 16:00**
Design Story Maps for Emotional Impact (John Nelson/Jennifer Bell)	**Tue 10:00 | Thu 16:00**
Choosing the Right Basemap (John Nelson/Andrew Skinner)	**Thu 14:30**

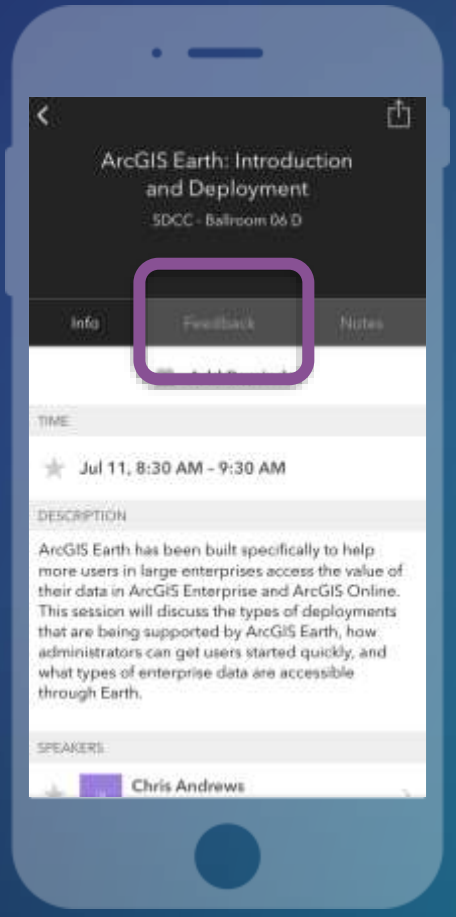
Please Take Our Survey on the App

Download the Esri Events app and find your event

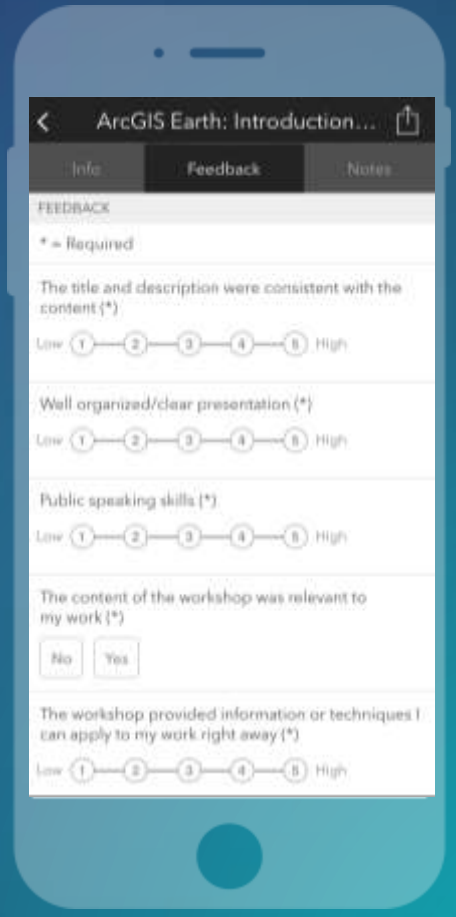
Select the session you attended



Scroll down to find the feedback section



Complete answers and select “Submit”



ABCDE
XYZ
RSTUV
W
GHIJ
LM NO

kfield@esri.com
WJones@esri.com

@kennethfield
@wesleytjones